Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

MARCH, 1950

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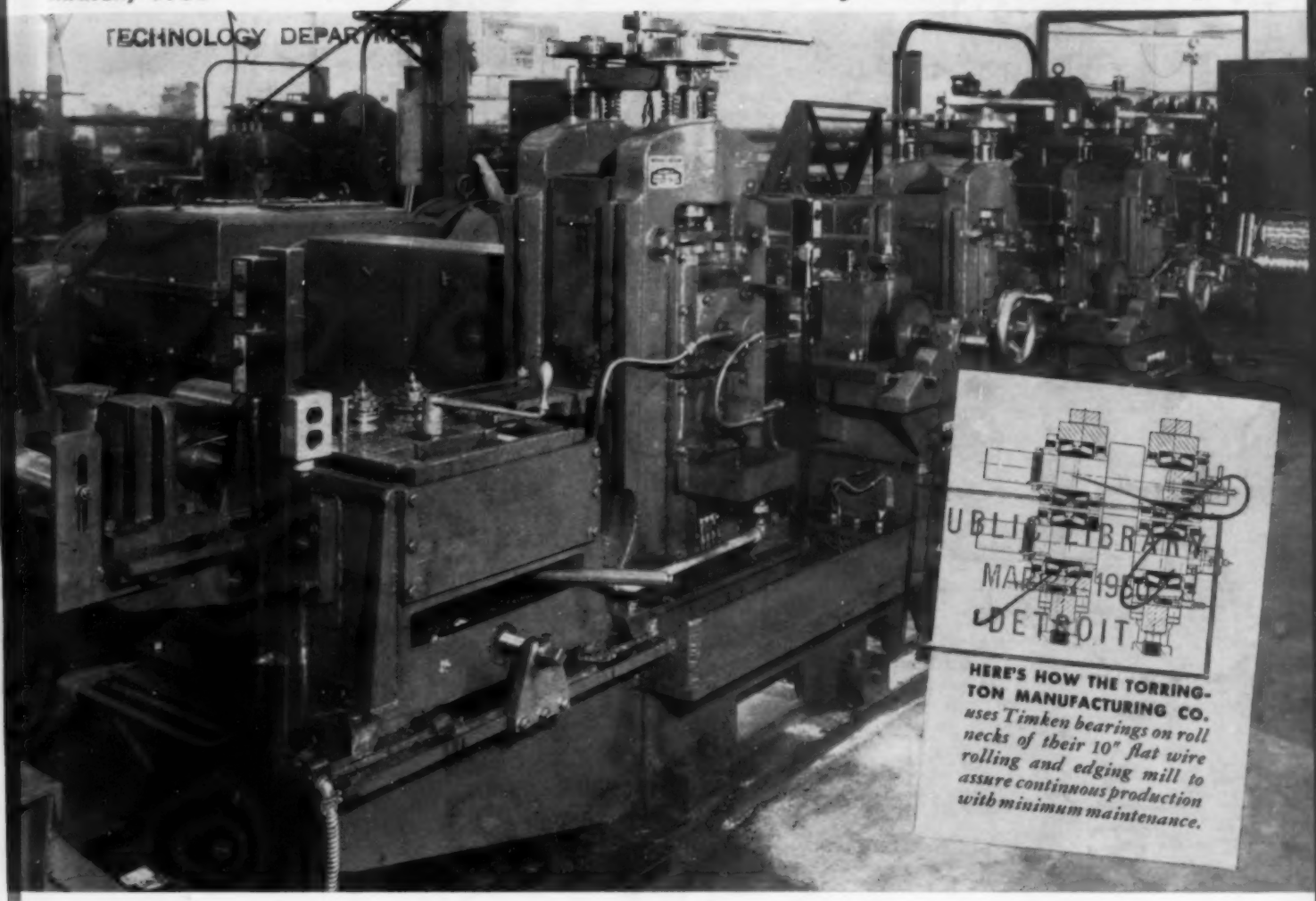


HERE'S HOW THE TORRINGTON MANUFACTURING CO. *uses Timken bearings on roll necks of their 10" flat wire rolling and edging mill to assure continuous production with minimum maintenance.*

Flattens wire...flattens costs... with TIMKEN® bearings on the rolls

TO insure long life and minimum maintenance in this Torrington 10" 3-stand tandem flat wire rolling and edging mill Timken® bearings are used on the roll necks, combined drives, and pinion stands.

Manufactured to extreme precision and finished to incredible smoothness, Timken tapered roller bearings make friction practically negligible. And Timken bearings permit tighter closures which retain lubricant longer.

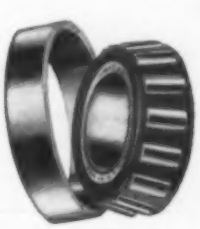
Due to the tapered construction of Timken tapered roller bearings, they carry any combination of radial and thrust loads. Maximum load capacity is provided by line contact between the rolls and races. Made of Timken alloy steel, they normally last the life of the machine.

Backed by over 50 years of bearing research and development, Timken bearings are first choice throughout industry. Look for the trade-mark "Timken" on every bearing you buy. The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO".

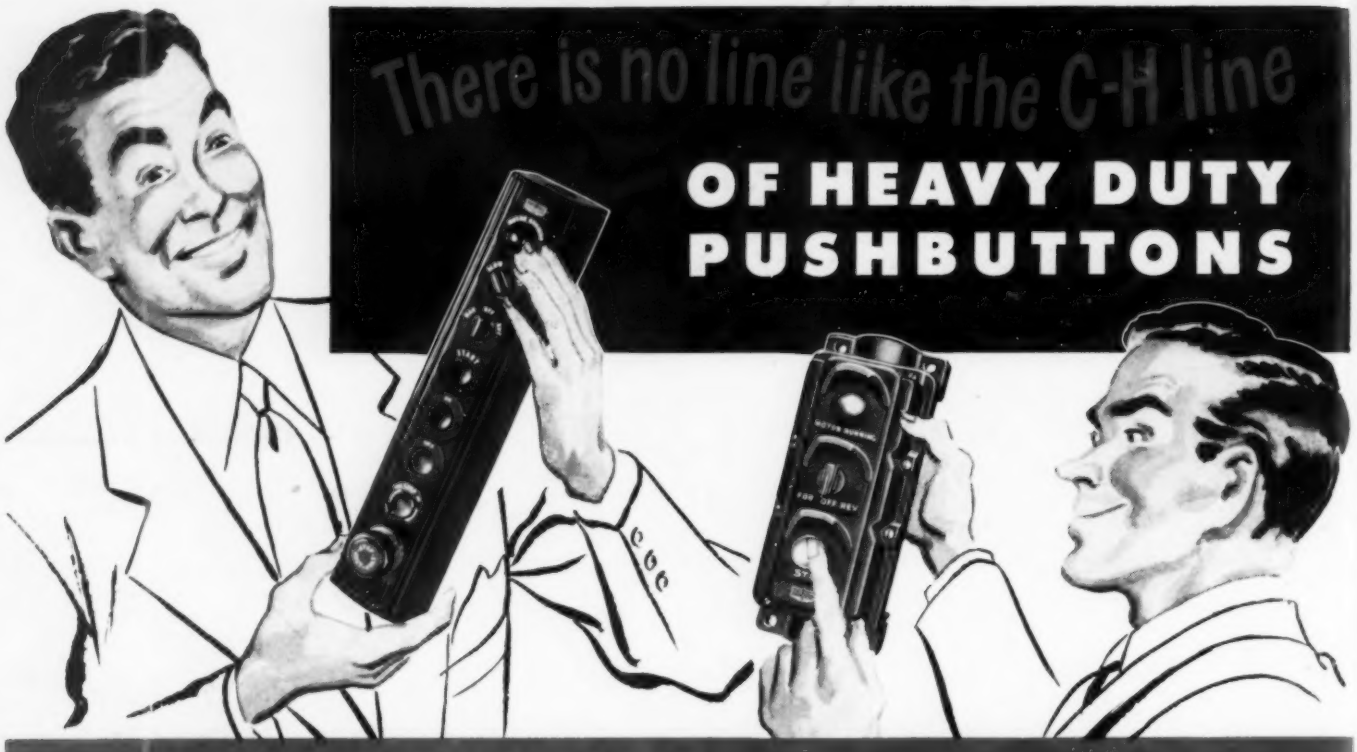
TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS



NOT JUST A BALL ◯ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ↓ AND THRUST →◯← LOADS OR ANY COMBINATION →◯←



EVERY TYPE OF OPERATOR

Plain Button Base Mounting | Plain Button One Hole Mounting | Maintained Contact Base Mounting | Latch Down Plain Button | Mushroom Head Base Mounting | Mushroom Head One Hole Mounting | Rotary Selector 2 or 3 Position | Maintained Contact One Hole Mounting | Oil-Tight One Hole Mounting | Indicating Light One Hole Mounting | Latch Safe Base Mounting

EVERY TYPE OF STATION

General Purpose | Oil Tight | Flush Mounting | Water and Dust Tight | Oil immersed, Hazardous Class I and II

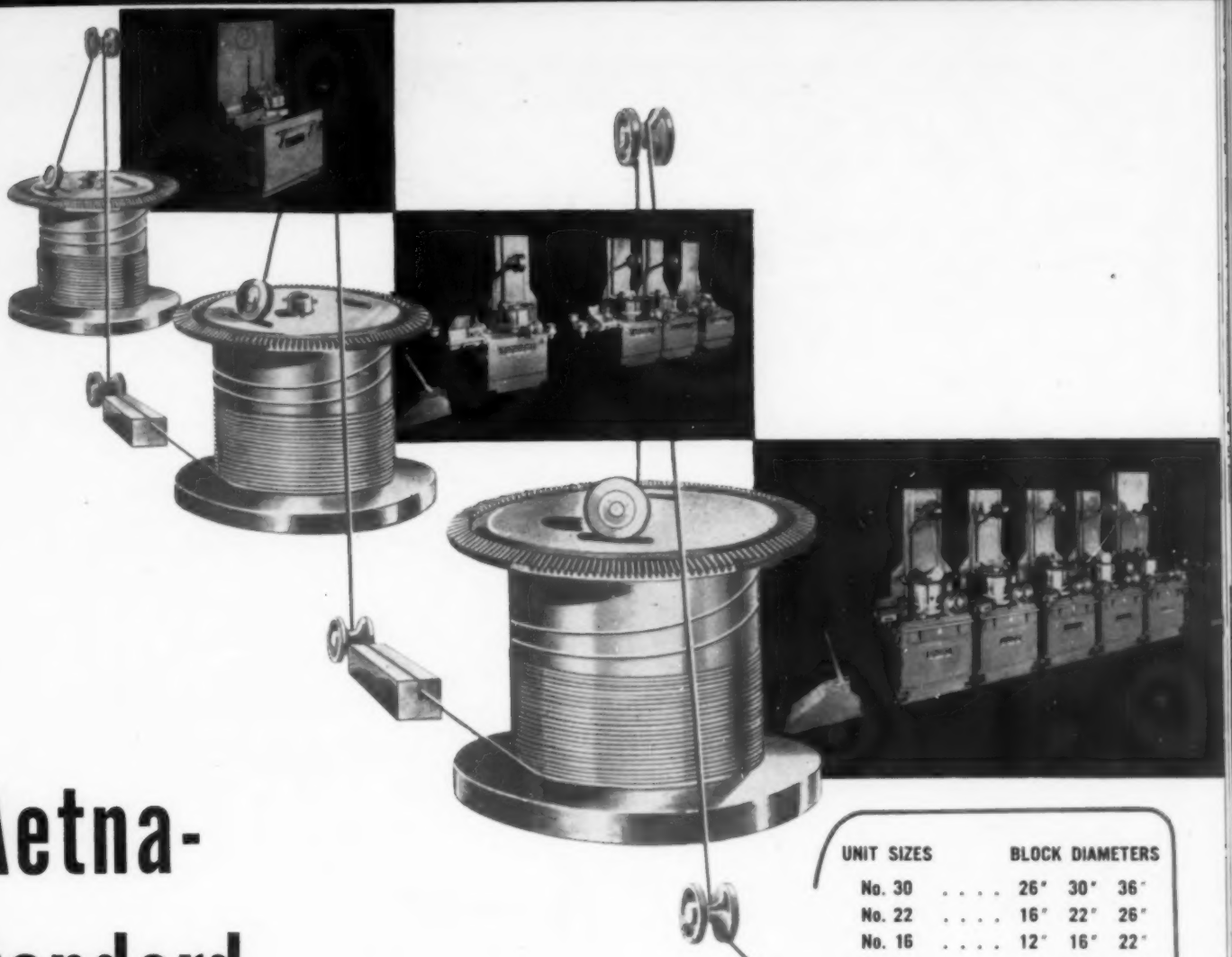
EVERY TYPE OF CIRCUIT COMBINATION . . . 32 IN ALL

The Cutler-Hammer line of heavy duty pushbuttons offers the widest selection, by far, of operators, elements, stations and circuit combinations. This line has the unique distinction of being designed and engineered from the very start for such broad coverage of needs . . . through the development of a fundamentally correct contact mechanism capable of being incorporated into diversified types of elements, an equally modern and extensive line of operators . . . and a maximum number of circuit combinations.

As a result, users have gained such advantages as: complete interchangeability, uniformity of design and performance, exceptionally long life, frequently the elimination of any need for additional relays, interlocks and the like, ease of installation through visible contacts which facilitate circuit identification and terminals which are unusually large and accessible, and attractive appearance. All basic elements have successfully undergone Underwriters' tests. Here is a line attractive to machine designers, machine buyers and maintenance men alike. CUTLER-HAMMER, Inc., 1269 St. Paul Avenue, Milwaukee 1, Wisconsin. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ontario.

CUTLER-HAMMER
MOTOR CONTROL
C-H

IRON AND STEEL ENGINEER; published monthly by Association of Iron and Steel Engineers, 1010 Empire Bldg., entered as second class matter January 25, 1924 at Pittsburgh, Pennsylvania, under Act of Congress, March 3, 1879. $7.50 per year in United States and Canada, $10.00 foreign countries. Volume 27, No. 3.



Aetna-Standard Wire Drawing Unit

UNIT SIZES	BLOCK DIAMETERS
No. 30	26" 30" 36"
No. 22	16" 22" 26"
No. 16	12" 16" 22"
No. 12	8" 12" 16"

● **Profitable Production**—Aetna-Standard Vertical Wire Drawing Machines are engineered to most effectively utilize the elements of labor, time, and space. Compact, sturdy construction assures long service at maximum production with a minimum of maintenance.

Efficiency and economy are inherent characteristics of Aetna-Standard construction. Proper arrangements of units to fit your production requirements can make every unit a continuous producer.

Tonnages are increased to a new level through Aetna-Standard design. Controlled water cooling of both dies and blocks, improved die boxes and holders, and auto-rheostatic synchronization between units all contribute to ease of operation and increased production.

New, usable versatility allows future rearrangement of individual units, and interchangeability of unit components (motor gearing and blocks, etc.). This is your insurance against obsolescence. The overhead wire take-off system offers many diversified adaptations and a wide range of draft schedules.

Automatic rheostat synchronizing control utilizes full speed range of each motor, effectively synchronizes speed of all units, controls reserves of wire on intermediate units, and provides **simple and safe automatic operation.** Ease of operation means greater production.

DESIGNERS AND BUILDERS to the Steel, Non-Ferrous and Chemical Industries

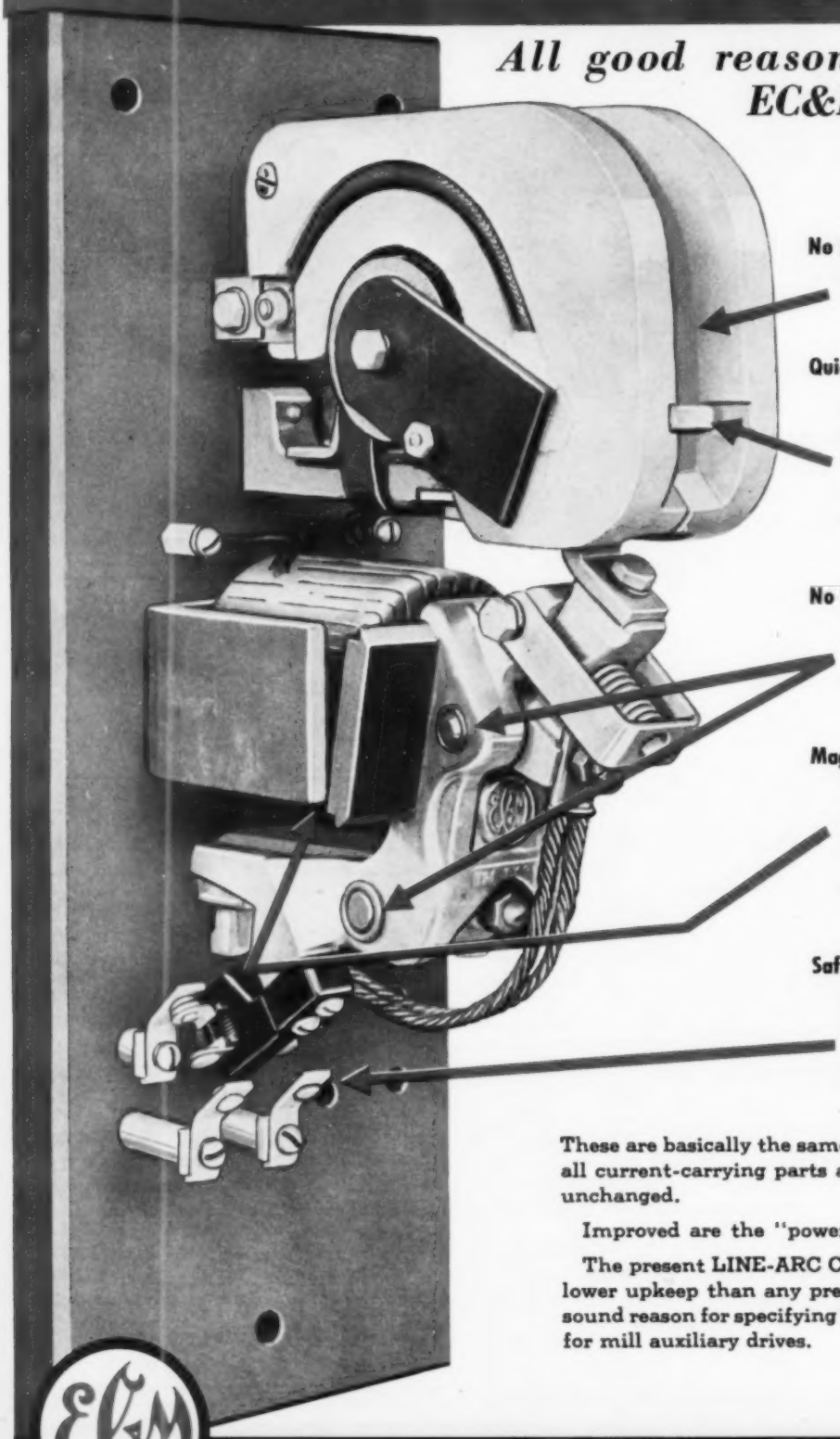
THE AETNA-STANDARD ENGINEERING COMPANY

YOUNGSTOWN, OHIO

ASSOCIATED COMPANIES:

AETNA-STANDARD ENGINEERING CO., LTD. TORONTO, ONTARIO, CANADA
HEAD, WRIGHTSON & COMPANY, LTD., THORNABY-ON-TEES, ENGLAND
SOCIETE DE CONSTRUCTIONS DE MONTBARD, 6 RUE DARU, PARIS (8e) FRANCE

Look at these *cost-reducing* features of EC&M *LINE-ARC* Contactors



All good reasons for specifying EC&M Magnetic Control

No Destructive Arc Shield Burning

The arc is a line centered *between* but *not* touching the arc shields.

Quick Removal of HOT-ARC from Contacts

As the contacts separate, the arc is transferred in 1/500th of a second from the contacts to the arcing-plate and circular guard over the blow-out coil.

Result is cool contacts, and cool contacts last longer.

No Lubrication-Maintenance

Self-lubricating bearings on main and auxiliary arms—(often-overlooked) lubrication-maintenance is eliminated.

Magnetic Dust Problem is Licked

New Magnetic circuit is unrestricted below the air gap.

Magnetic dust free to fall. No mechanical shelf to catch it—dust does not pile up in air gap nor pack in, requiring manual removal.

Safer Electrical Interlocking

Double-break coin-silver contacts with normally-open circuit *insulated* from normally-closed circuit, no carry over from one to the other by an arc.

These are basically the same as original LINE-ARC Contactors—all current-carrying parts and the LINE-ARC principle remain unchanged.

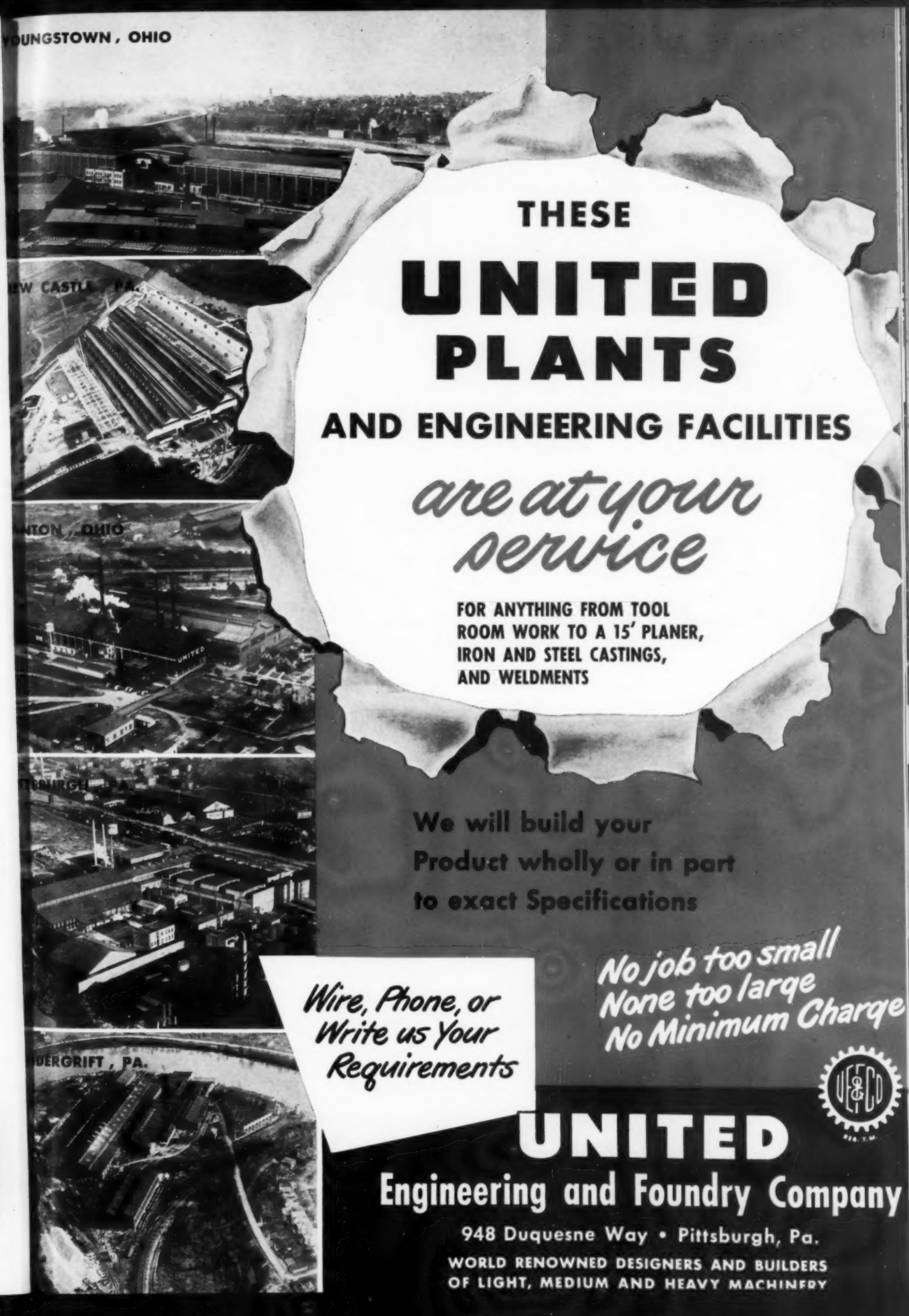
Improved are the "power-plant" and electrical interlocks.

The present LINE-ARC Contactors have higher efficiency and lower upkeep than any previous design magnetic contactor. A sound reason for specifying EC&M Magnetic Control for cranes—for mill auxiliary drives.

E C & M

THE ELECTRIC CONTROLLER & MFG. CO.

2698 EAST 79TH STREET ★ CLEVELAND 4, OHIO



THESE UNITED PLANTS

AND ENGINEERING FACILITIES

are at your service

FOR ANYTHING FROM TOOL ROOM WORK TO A 15' PLANER, IRON AND STEEL CASTINGS, AND WELDMENTS

We will build your Product wholly or in part to exact Specifications

No job too small
None too large
No Minimum Charge

Wire, Phone, or Write us Your Requirements

UNITED

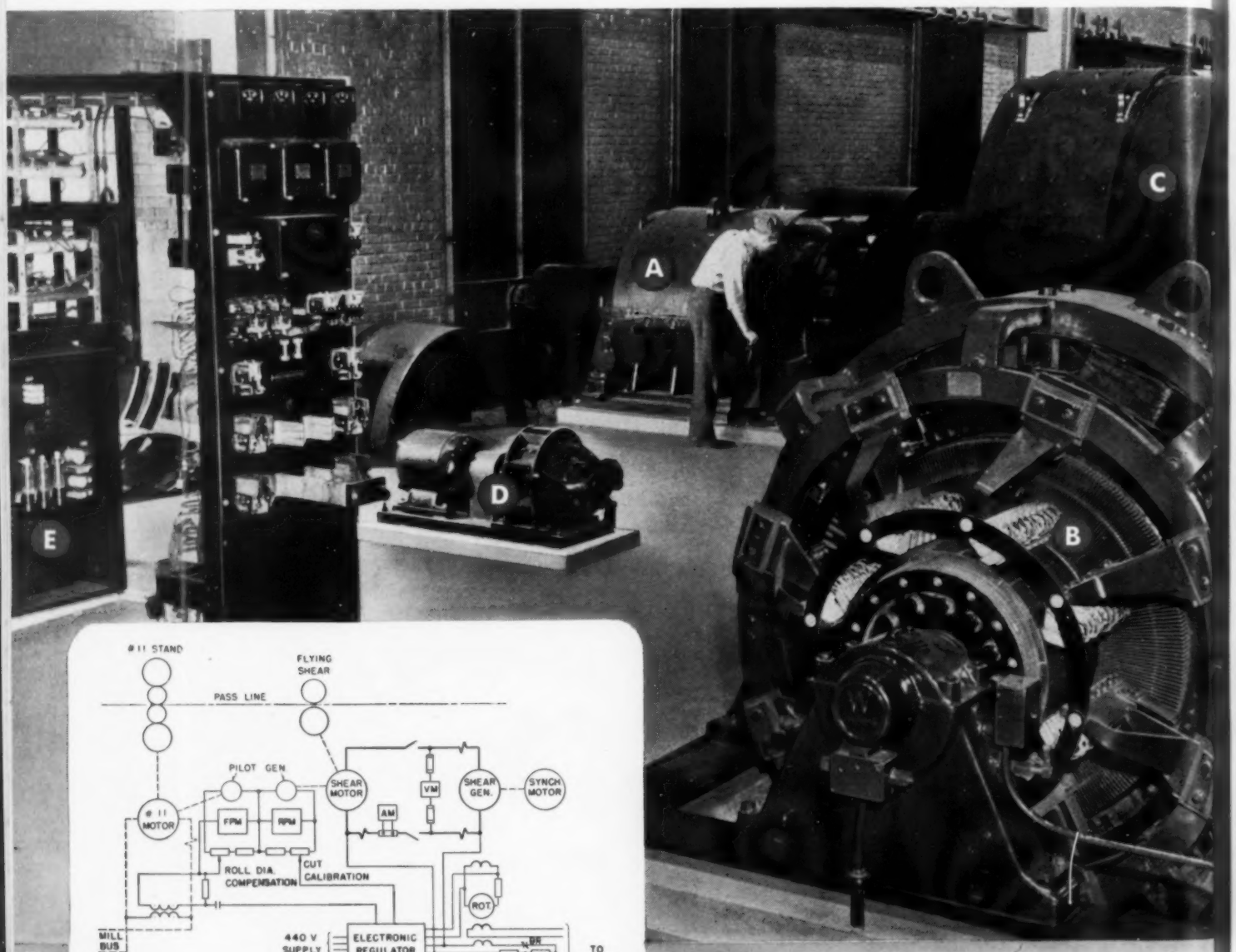
Engineering and Foundry Company

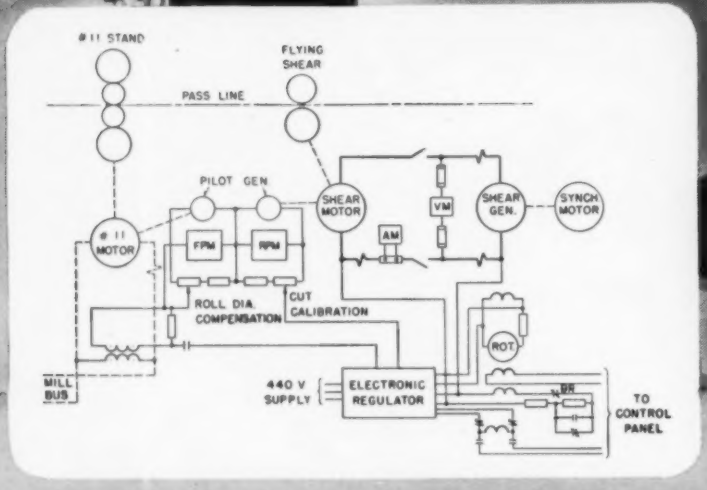
948 Duquesne Way • Pittsburgh, Pa.

WORLD RENOWNED DESIGNERS AND BUILDERS OF LIGHT, MEDIUM AND HEAVY MACHINERY

YOU CAN BE **SURE**.. IF IT'S

Westinghouse





IMPROVED FLYING SHEAR DRIVE

This Flying Shear Drive is a good example of the way Westinghouse coordination pays off. Designed for hot strip mills, it cuts strip into *accurate* lengths, eliminates the operating and maintenance difficulties inherent in mechanical and hydraulic drives. Here's how it works.

The Drive equipment is in the mill motor room. A single Main Motor (A) with high peak torque drives the bottom shear knife directly. Speed drops during the cut are overcome in an average of 0.2 seconds—a big factor in cutting accuracy. The only gears in the system are between the bottom and top knives. Fewer gears mean less maintenance, greater reliability.

Power supply for the Main Shear Motor is a d-c generator (B) driven by a synchronous motor.

PILOT GENERATORS AND ROTOTROL SYNCHRONIZE SHEAR WITH MILL

The Shear and Mill are synchronized by two pilot generators, one *geared* to the Shear Motor, the other to the last finishing stand motor (C). The voltage outputs of the two generators are connected to oppose each other. (See diagram.) Thus, when the differential voltage is zero, the Shear and Mill are synchronized.

The voltage differential existing before synchronization is fed into the Rototrol Regulator (D) and the Electronic Regulator (E). They combine to synchronize the Shear and Mill *and* provide infinite speed control within the operating range. They also control acceleration and retardation. The Shear is easily stopped, reset and started as each slab goes through the mill. This cuts scrap loss.

This Shear Drive meets the fundamental requirements. It's simple and reliable, easily regulated, has excellent synchronization and complete speed variation. It saves money, cuts strip more accurately.

SURE WAY

to get

Co-ordinated Auxiliary Drives

Planning a new cold mill? Expanding slabbing capacity? Modernizing your open-hearth shops? Whatever the job, the Auxiliary Drives you choose will have a big effect on its performance.

There's a sure way to get the *intricate co-ordination* needed to develop the "one best" Auxiliary Drive—let Westinghouse handle the job. We've had a tremendous amount of experience with Drives—more than any other manufacturer. We know the problems and how to go about solving them.

Right from the beginning, Westinghouse Steel Mill Specialists consult with you and the equipment builders. Help select the motors, speed reducers, controls and switchgear. Co-ordinate the whole installation. Make the plant layout drawings if you wish. And most important—*stay with the job until it's running just as it's designed to.*

Co-ordinated Auxiliary Drives by Westinghouse are proving themselves in hundreds of steel mill applications. Chances are they're saving power and maintenance and helping turn out superior products in your mill today. When you're planning new capacity or modernizing, get in touch early with your Westinghouse office. Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania.

J-94814

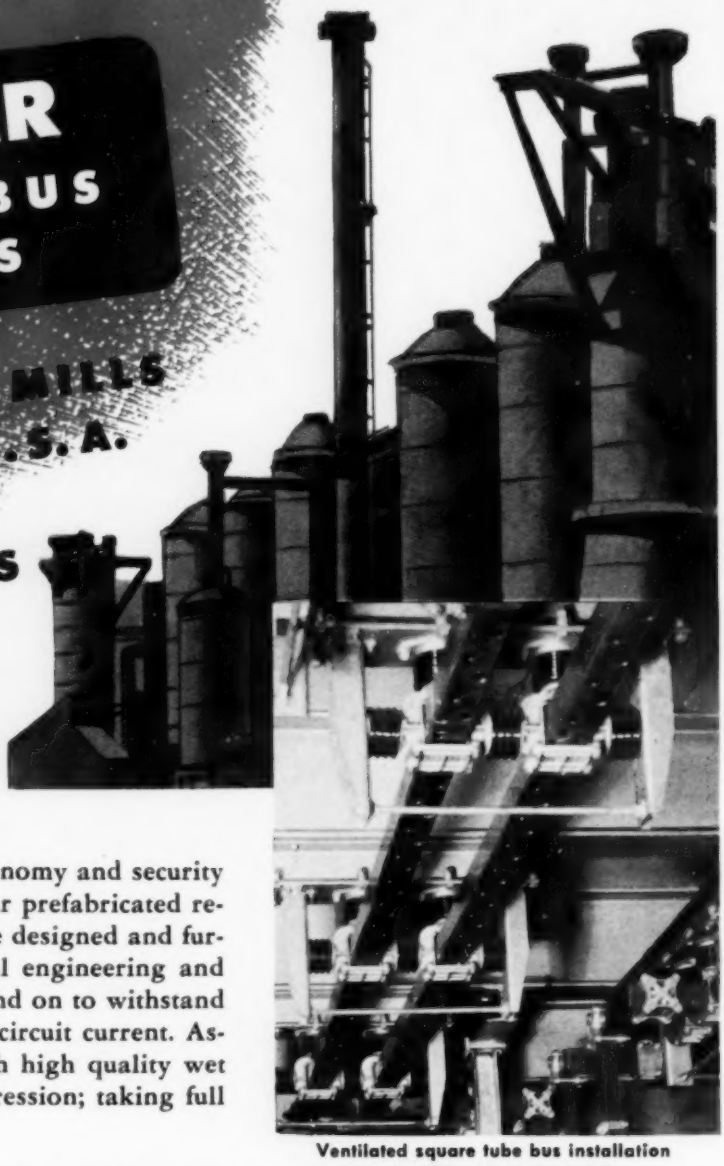
Westinghouse

EQUIPMENT FOR THE STEEL INDUSTRY

DELTA-STAR REINFORCED BUS STRUCTURES

ARE INSTALLED IN MILLS THROUGHOUT THE U. S. A. AND IN MANY FOREIGN COUNTRIES

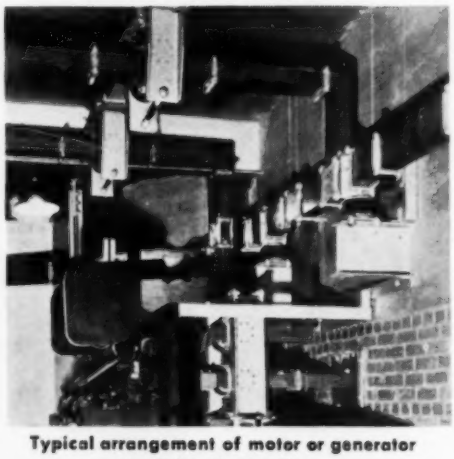
FOR GREATEST SAFETY in Event of Short-Circuit



Ventilated square tube bus installation in a midwestern steel mill.

Leading steel mills have recognized the economy and security which is inherent when installing Delta-Star prefabricated reinforced bus structures. These structures are designed and furnished complete to the last detail. Careful engineering and fabrication assure a structure you can depend on to withstand the destructive forces resulting from short circuit current. Assemblies consist of heavy steel frames with high quality wet process porcelain insulators used in compression; taking full advantage of their greatest strength.

Our engineers will be glad to discuss your bus problems and work out a layout to suit your special requirements. Prefabricated open or enclosed bus structures are available for aluminum or copper bars and tubing; structural and special shapes; indoor or outdoor service.



Typical arrangement of motor or generator circuit-breaker sections.

OTHER DELTA-STAR PRODUCTS
Used in Mills and Industrial Plants

- Crane Rail Supports
- Disconnecting Switches
- Terminators (Potheads)
- Plugs and Receptacles
- Spool Insulator Cable Supports
- Water Cooled Conductors and Fittings
- Interrupter Switches
- Power Connectors

DELTA-STAR ELECTRIC COMPANY

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NEW YORK OFFICE — 140 Cedar St., New York 6, N. Y.

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CANADIAN ASSOCIATE
Canadian Line Materials Limited — Toronto 13, Canada

(Partial view of the enormous new lubricating oil plant at Lake Charles, La., where this great new oil is processed.)

"ANTI-FOULING" OIL made by the Remarkable new "HEART-CUT" PROCESS

This new oil—the best known to science... gives you a cleaner engine... more economy ...minimum carbon residue.

It's here now! The remarkable motor oil from the giant new $42,000,000 lubricating oil plant at Lake Charles, La. The plant that's been the big talk of the oil industry for months.

New Premium Koolmotor is made by the unique "Heart-Cut" Process which retains only the choicest part of the finest crudes. *It's so superior that in recent engine tests it outscored nine other major premium motor oils.* No wonder Premium Koolmotor is better in every way! Cleans better, seals better, cools better and fights acid, sludge and corrosion far more effectively. Switch to this remarkable new oil today.

start saving Dollars today... stop at

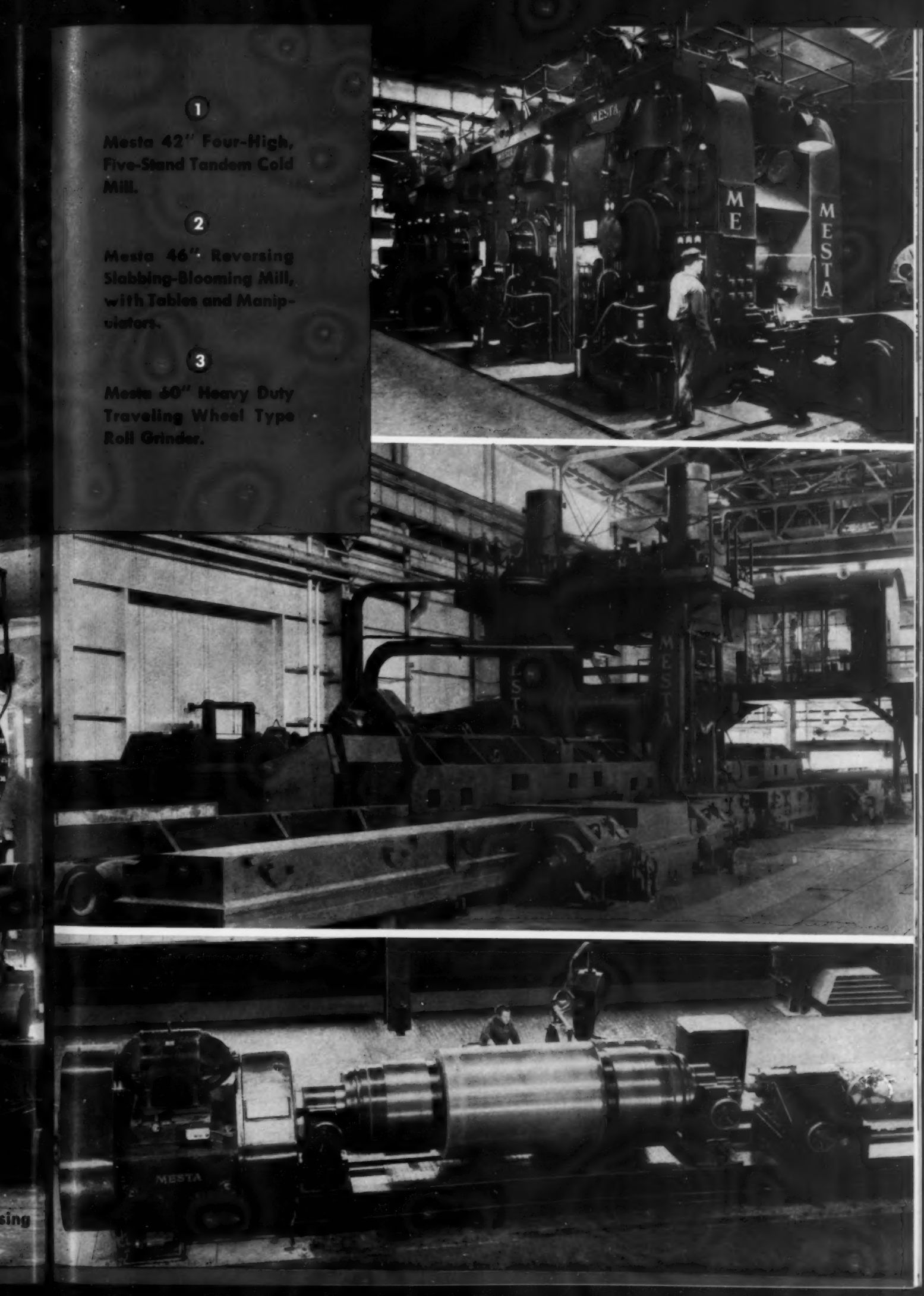
CITIES SERVICE

MESTA

MACHINE
COMPANY
PITTSBURGH,
PENNA.

Designers and Builders of Complete Steel Plants

Mesta 140" Four-High Reversing Plate Mill.



1

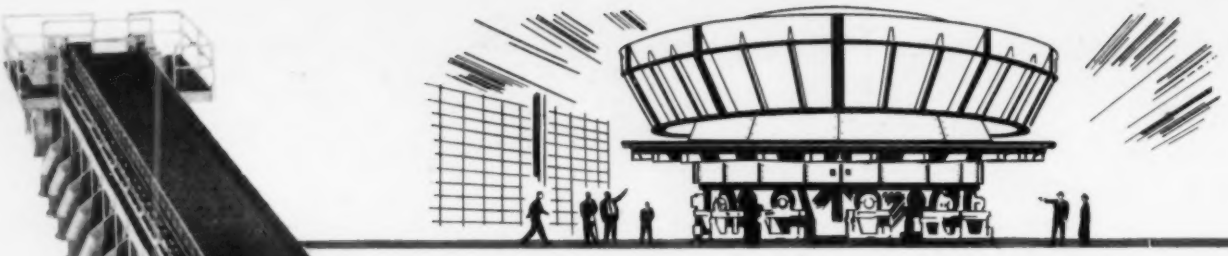
Mesta 42" Four-High, Five-Stand Tandem Cold Mill.

2

Mesta 46" Reversing Slabbing-Blooming Mill, with Tables and Manipulators.

3

Mesta 60" Heavy Duty Traveling Wheel Type Roll Grinder.



POLLOCK

chosen to construct latest sintering plant equipment

McKee 16
Wind Box
Sintering Machine

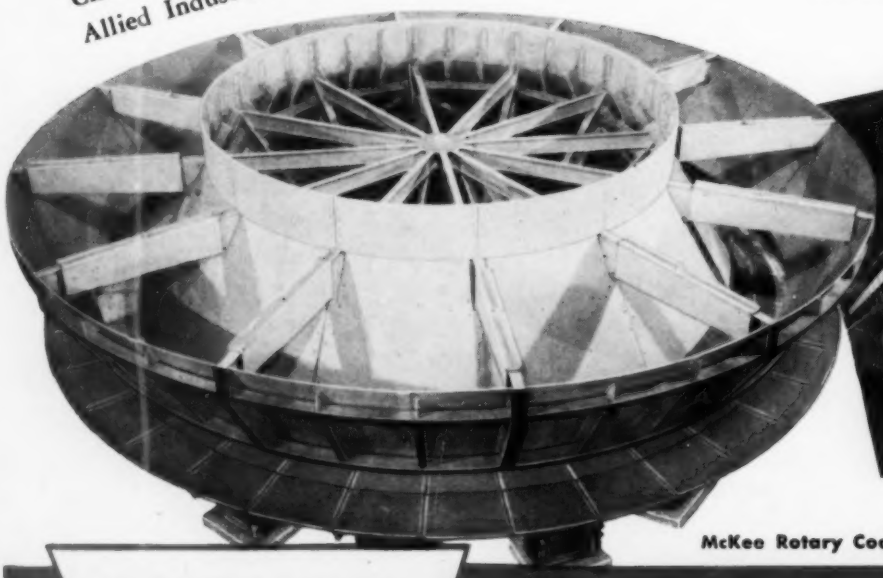
POLLOCK ALSO MAKES . . .

Miscellaneous Welded and Riveted Steel Plate Work for Blast Furnaces and Steel Plants, Oil Refineries, Chemical Plants and Allied Industries.

TO construct its newly developed sintering plant equipment, Cleveland's Arthur G. McKee Company chose The William B. Pollock Company, steel plate construction experts since 1863.

This latest sintering machine and rotary cooler were assembled in Pollock's Youngstown, Ohio plant and inspected by the customer and many interested iron and steel operators and engineers while in test operation. Then it was thoroughly match-marked, disassembled, and loaded on 16 railroad cars in such a way as to insure quick and efficient field erection.

Pollock is known the world over for its reliable, efficient heavy plate construction.



McKee Rotary Cooler 48 Ft. 4 In. Diameter

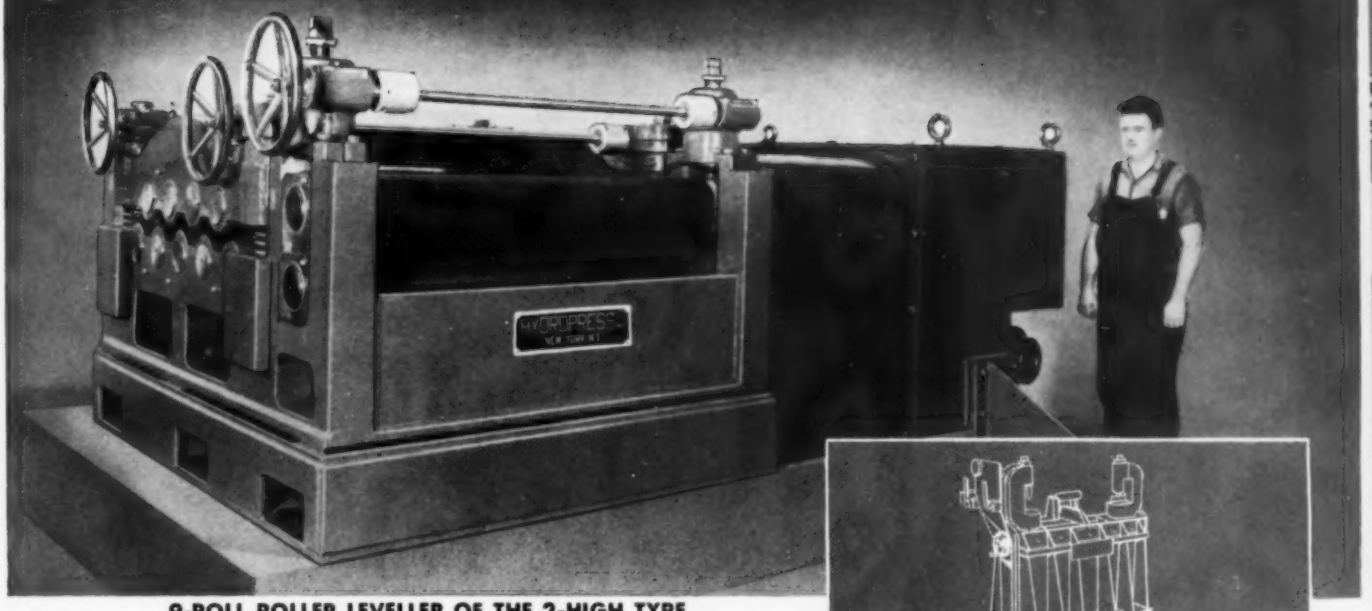
Discharge end McKee Sintering Machine

POLLOCK

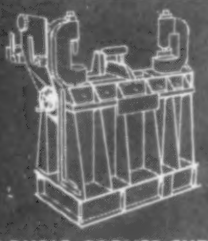
THE WILLIAM B. POLLOCK COMPANY
YOUNGSTOWN · OHIO
STEEL PLATE CONSTRUCTION · ENGINEERS · FABRICATORS · ERECTORS

BLAST FURNACES · HOT METAL CARS AND LADLES · CINDER AND SLAG CARS · INGOT MOULD CARS · CHARGING BOX CARS · WELDED OPEN HEARTH LADLES

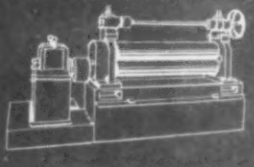
WE BUILD ROLLING MILL MACHINERY



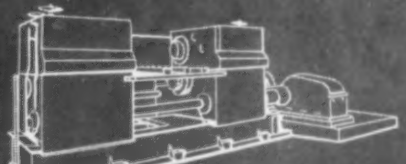
9-ROLL ROLLER LEVELLER OF THE 2-HIGH TYPE



UP-CUT DOUBLE CORNER CUTTING SHEAR



PINCH-ROLL STAND WITH INDIVIDUAL DRIVE



SIDE-TRIMMING SHEAR FOR STEEL SHEET

for the ferrous and non-ferrous industries

to the individual production requirements of our customers

LEVELLING, TRIMMING AND SHEARING LINE

for Steel Sheet from 15″ to 48″ wide and 0.188″ to 0.4″ thick, up and including J-55

designed and built for the new pipe mill of

KAISER STEEL CORPORATION
KAISER ENGINEERS DIVISION OF KAISER INDUSTRIES, INC.
ENGINEER-CONTRACTOR

SPECIFY YOUR REQUIREMENTS AND ASK FOR DETAILS

HYDROPRESS · INC.

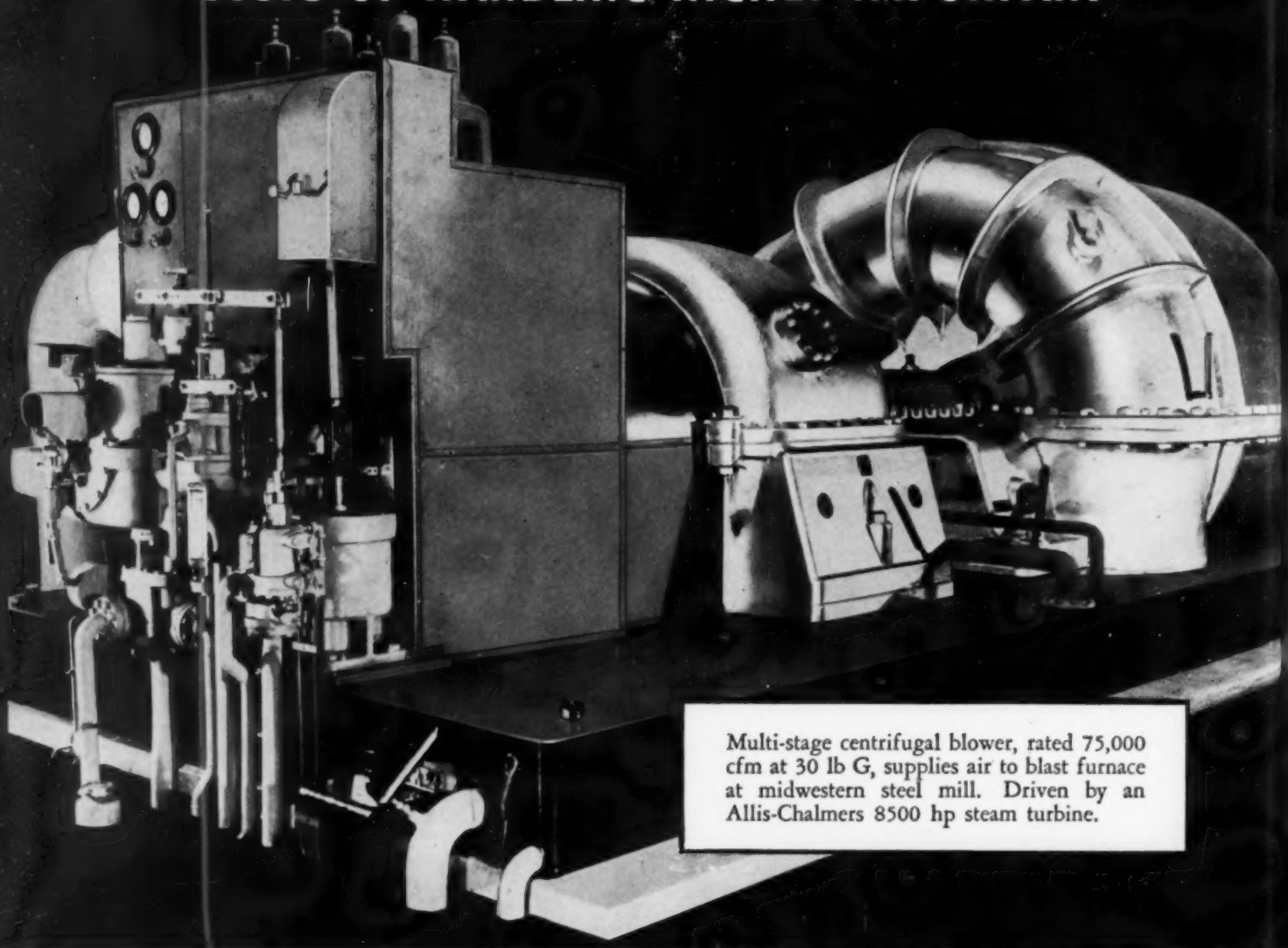
ENGINEERS CONTRACTORS

HYDRAULIC PRESSES · ROLLING MILLS · PUMPS
ACCUMULATORS · DIE CASTING MACHINES

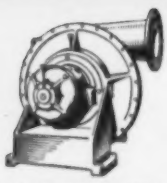
566-568 LEXINGTON AVENUE AT 51st STREET NEW YORK 22 · N. Y.
CHICAGO DETROIT SAN FRANCISCO SEATTLE WASHINGTON, D. C.

There's More Air than Ore in Iron!

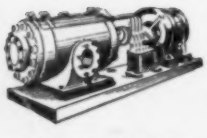
3.5 TONS OF AIR SUPPLIED TO BLAST FURNACE TO MAKE ONE TON OF IRON; COSTS OF HANDLING HIGHLY IMPORTANT



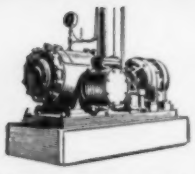
Multi-stage centrifugal blower, rated 75,000 cfm at 30 lb G, supplies air to blast furnace at midwestern steel mill. Driven by an Allis-Chalmers 8500 hp steam turbine.



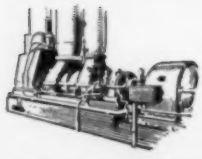
SINGLE STAGE BLOWERS available in pressure ranges from one to 6.50 lb. Rigid, long-lived cast casing can be arranged to any one of 24 discharge positions.



ROTARY COMPRESSORS, sliding vane type. Capacities for 5 to 35 psi-g. Air is compressed in cells formed by blades moving freely in and out of longitudinal slots in rotor.



DRY VACUUM PUMPS. Range to 28½ inches hg vacuum. Same principle as rotary compressors except that action is reversed—inlet evacuates, exhaust is open.



AXIAL COMPRESSORS. Compress to 60 lb gauge with high efficiencies. *Good base load machines. Used with gas turbines.* Cannot build up dangerous pressures.

ALLIS-

Power, Electrical,

DON'T OVERLOOK THE IMPORTANCE OF AIR in the making of iron and steel. True, there's no mining, no purchasing, no shipping. But even though air is *free*, handling costs for air are just as important as for other raw materials!

These costs are even more important, when you consider their relation to material cost. And, three and half *tons* of air — *more than all other ingredients combined* — are supplied a blast furnace in producing one ton of iron. Large quantities of air are likewise all-important for oxidation in the open hearth and bessemer converter processes of steelmaking.

REGULATED AIR FLOW IMPERATIVE FOR GAS, COKE PRODUCTION

A "must" for securing a uniform grade of coke for blast furnace fuel, is the maintenance of constant pressure in coke ovens and gas collector mains. Dependable performance and accurate speed control of exhauster (lower) are necessary also for maximum by-product yield.

Centrifugal booster (upper right) equipped with automatic speed regulation forces the coke oven gas from storage to processing or use. Both exhausters and boosters contribute materially to *efficient* coke plant operation . . . reduce waste and add to profits.

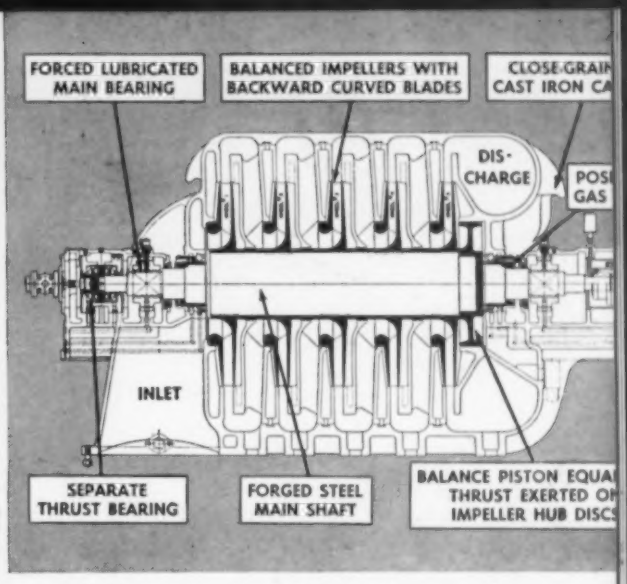
ALLIS-CHALMERS BUILDS FIVE KINDS OF BLOWERS AND COMPRESSORS

Allis-Chalmers builds a wide range of equipment, including *five* kinds of blowers and compressors (see lower left) . . . all necessary electric motors and controls . . . both gas and steam turbines . . . condensers for steam turbines. If supplied by A-C, your blower-drive "team" will be specifically engineered to fit the application and to work together.

Allis-Chalmers centrifugal blowers now are being used extensively in the iron and steel industry and in manufactured gas plants. This experience will help *you* solve your *particular* air and gas handling problems. A qualified A-C steel mill representative will be glad to discuss them with you.

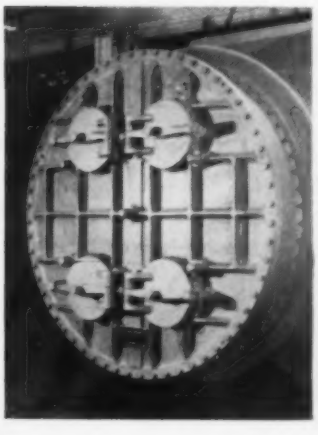
A-2972

ALLIS-CHALMERS, 1020A SO. 70 ST.
MILWAUKEE, WIS.

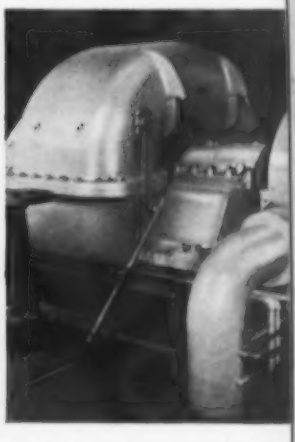


Multi-stage centrifugal blower of type used as gas booster in coking plants. Note liberal design.

Five stage gas booster. Handles 10,600 cfm at 13 lb G. Allis-Chalmers 800 hp, 6290 rpm synchronous motor.



Allis-Chalmers 11,000 sq. ft 2-pass surface condenser used for steam turbine driven blast furnace blower.



Multi-stage gas exhauste Handles 33,000 cfm at 85 i water G. Driven by 665 h steam turbine.

al,

S-CHALMERS

Processing Equipment for Iron and Steel

A-C ALLIS-CHALMERS

TEEMING METAL
AS SEEN WITH
L&N OPTICAL PYROMETER
Note Usefulness of Big Image when smaller does not approximately fill Pyrometer field.
WITH 2-INCH TIP
WITH 4-INCH TIP
WITH 2-INCH TIP
FURNACE ROOF
AS SEEN WITH
L&N OPTICAL PYROMETER
Smaller image is more Useful, though either large or small can fill Pyrometer field.
WITH 4-INCH TIP

Better Information About Temperature From Present L&N Optical Pyrometers

The important job of checking temperature by simply sighting an instrument on the hot object is the steel industry's task for L&N Optical Pyrometers. Because Opticals do not change accuracy when ambient temperature rises or falls, they can be kept handy to the furnace, ready for use at any time. Because they use the potentiometer principle, these portable instruments measure dependably and accurately. And, now, they are easier to use than ever before because the user can have two choices in the apparent size of his "target." All that's needed is a pyrometer tip of 4" focal length, to supplement the standard 2" tip.

With the 2" tip, the area seen by the user is 5½ inches in diameter at 5 feet; proportionately more or less at other distances. With the long tip, the field is the same size, but the image is twice as large, so that men who formerly had difficulty in getting readings now obtain them more quickly and with less effort.

Optical Pyrometers are available in Fahrenheit ranges from 1400 to 5200, or in the corresponding Centigrade ranges of 775 to 2800, or in convenient portions of each spread. Instruments can be direct-reading for the normal "black body" conditions inside a furnace, or for molten metals. All choices, as well as the extra tips, are fully described in Catalog N-33D, which also has many pictures showing equipments in use. For a copy, write Leeds & Northrup Co., 4942 Stenton Ave., Philadelphia 44, Pa.

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LEEDS & NORTHRUP CO.

Jrl. Ad N-33D-0660(1)

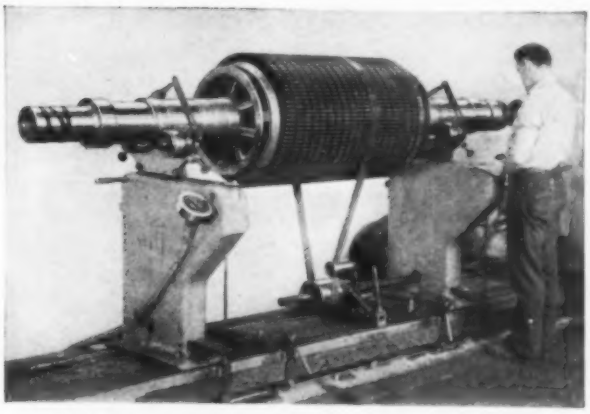
LOW inertia for HIGH production

500-hp, 250/965 rpm, 600-volt direct-current motor, enclosed, force ventilated.

ELLIOTT
FABRI-STEEL
MOTORS

FOR MODERN HIGH-SPEED ROLLING MILLS, the rapid acceleration and deceleration required are provided by Elliott "Fabri-Steel" motors expressly designed for this service in both reversing and non-reversing applications. Smaller diameter armatures and other design features combine with painstaking attention to details in engineering and workmanship to produce a superior machine, meeting the most exacting needs of rolling mill drives.

Write for Bulletin PB 8200-1.



Small diameter armature core for above motor is carefully balanced. Spider and shaft are made in one piece from a single steel forging.

OTHER FEATURES

Flawless commutation • Close speed regulation • Rugged construction with heavy overload capacity • Equal division of load on twin drives • Ready accessibility for inspection and maintenance.

MR-2A

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Department IS
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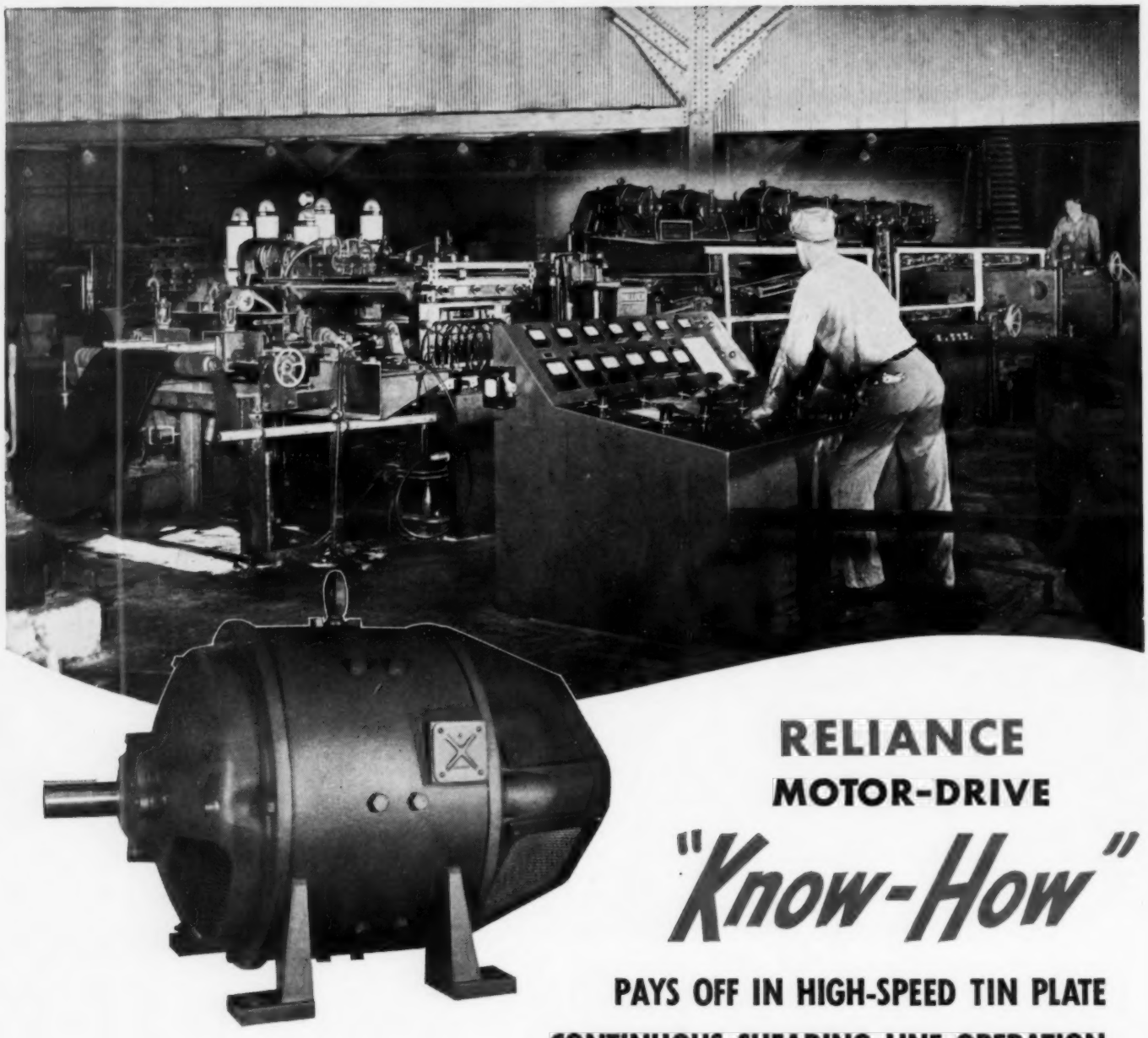


RELIANCE
MOTOR-DRIVE
"Know-How"
PAYS OFF IN HIGH-SPEED TIN PLATE CONTINUOUS SHEARING LINE OPERATION

RELIANCE V★S SYSTEM

High output and low unit cost are made possible by synchronized electric motor-drives which provide smooth acceleration, high production speeds and continuous running at those speeds. In the high-speed tin plate shearing line, shown above, the motor-drive embodies the experience gained by Reliance through more than forty years of process line drive development. Reliance motor-drive 'know-how' is in evidence throughout the steel industry in cleaning, pickling, tinning, slitting, shearing and related continuous process operations. It will pay you, too, to consult a Reliance application engineer.

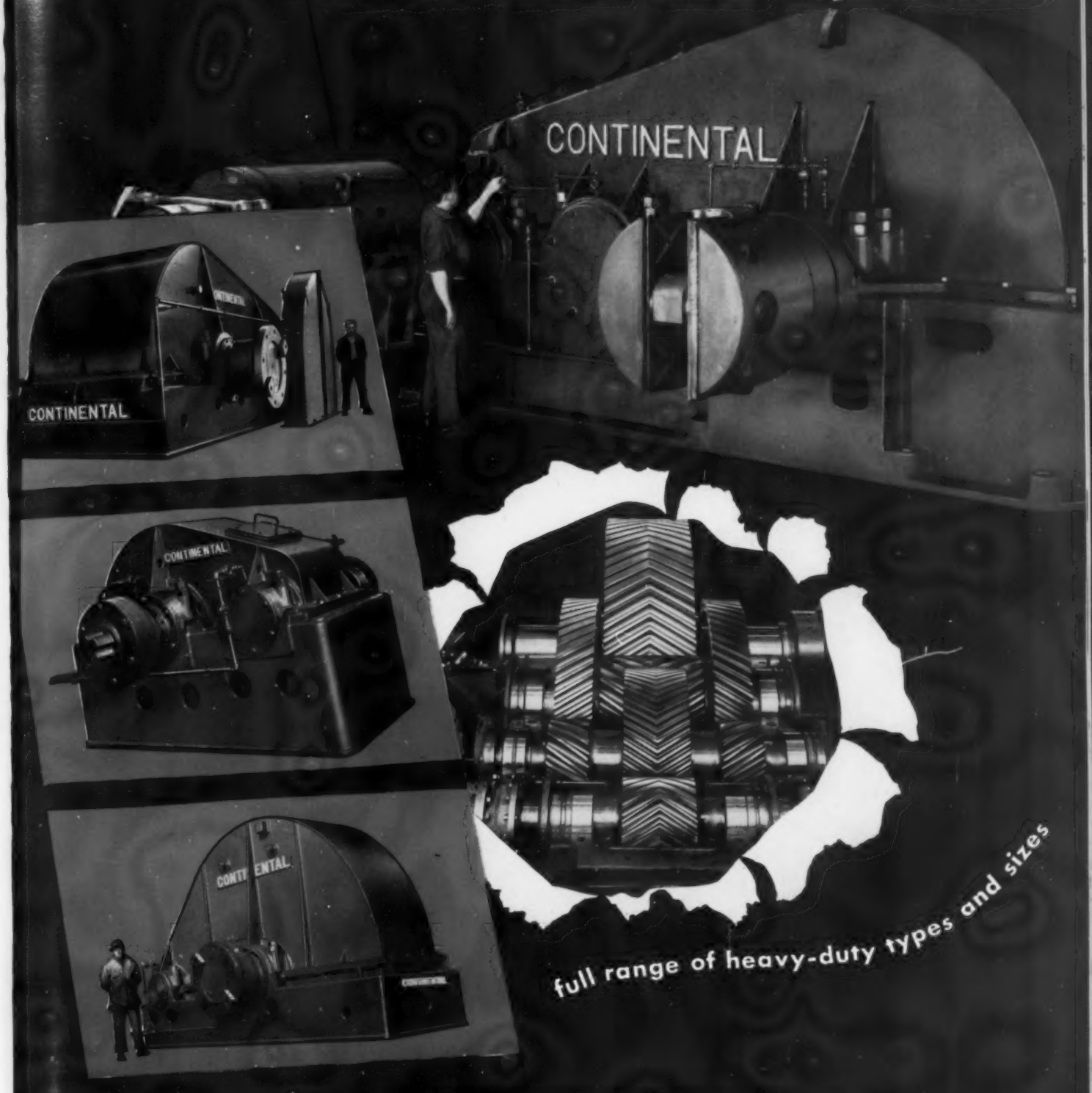
Sales Representatives in Principal Cities

RELIANCE ELECTRIC AND ENGINEERING CO.

"Motor-Drive is More Than Power" • 1084 Ivanhoe Road, Cleveland 10, Ohio

Continental gear drives

for HEAVY-DUTY MILL EQUIPMENT



full range of heavy-duty types and sizes

Continental

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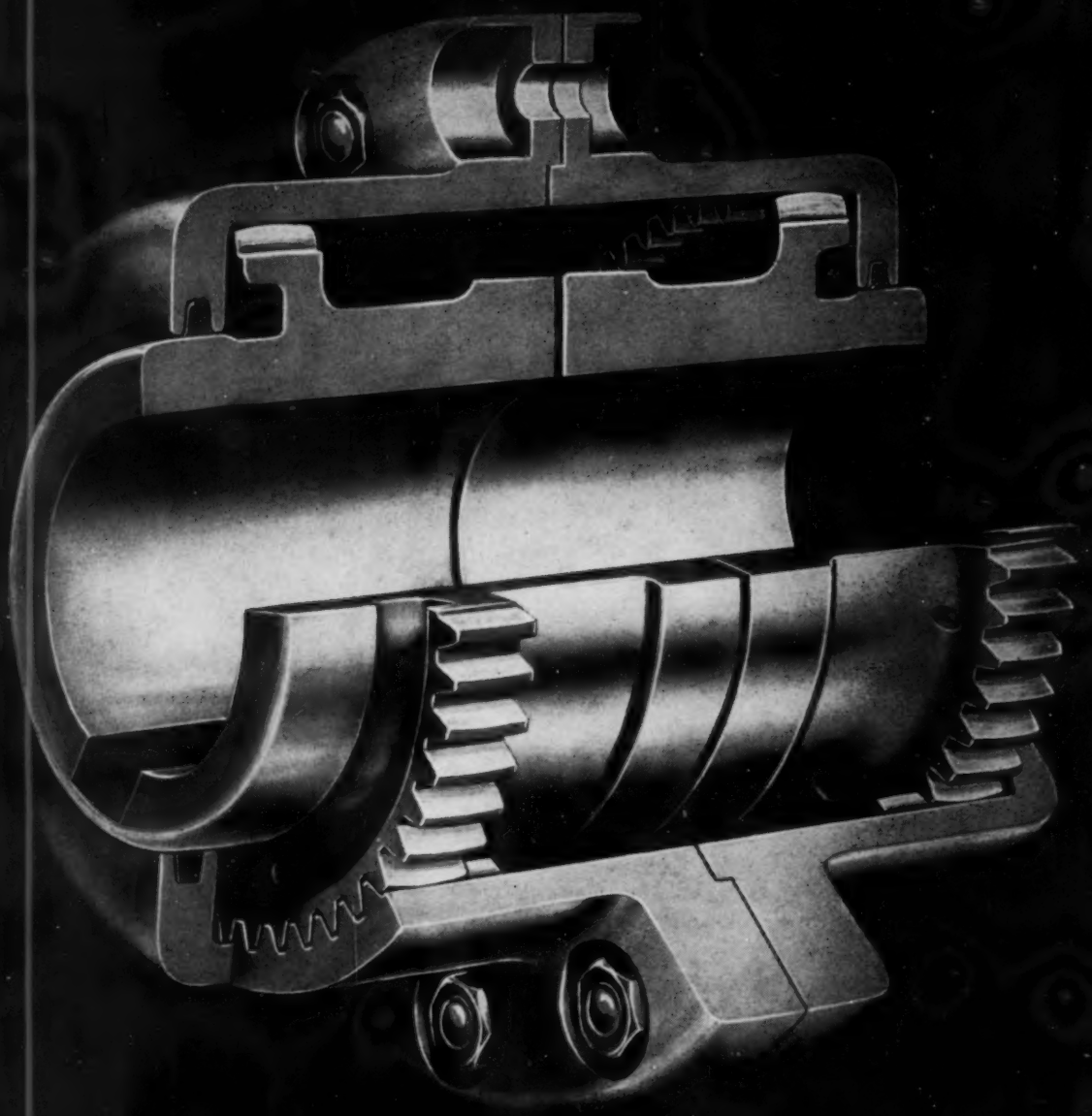
Complete Rolling Mill and Auxiliary Equipment Installations

Iron, Alloy Iron and Steel Rolls for all Industries

Steel Castings from 20 to 250,000 pounds

POOLE



OPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

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OLE FOUNDRY & MACHINE COMPANY

WOODBERRY, BALTIMORE, MD.

Why P&H *Job-Engineered* Cranes mean better service for you

When you buy a P&H Overhead Crane, you buy proved performance. Your crane will be *engineered* to meet the requirements of your specific job — coordinated with P&H electrical equipment, designed . . . not adapted . . . for crane service. There will be ample reserve capacity, adequate service life, maximum safety and every modern operating advantage. All these combine to give you long years of crane service with the least trouble and maintenance cost.

P&H Magnetorque* control for AC cranes brings you one of the most important improvements of the past 20 years. Ask your P&H Sales Engineers about it.

These are Added Values which P&H has learned to put into the building of overhead cranes through 65 years of progressive leadership. Perhaps that explains the overwhelming preference for P&H Cranes.

*T.M. of Harnischfeger Corporation for electro-magnetic type brake.

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Milwaukee 14, Wisconsin

HARNISCHFEGER CORPORATION

Write for your copy of Bulletin C-39 describing P&H Magnetorque Control for AC cranes.

6,000 P&H CRANES SERVE AMERICAN INDUSTRY — FAR MORE THAN ANY OTHE

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If you're using reciprocating or centrifugal pumps . . .

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SQUARE D MILL-TYPE MASTER SWITCHES

Class 9003, Type AD
cam-type master switch
in dust-tight enclosure

Features that Count WITH

THE OPERATOR—

Return spring pressure adjustable to individual preference. Twice normal spacing isolates OFF point—makes it easy to locate. Offset handles permit group mounting.

THE SAFETY ENGINEER—

OFF position latch (removable when unnecessary). Spring return to OFF position (convertible from manual return device).

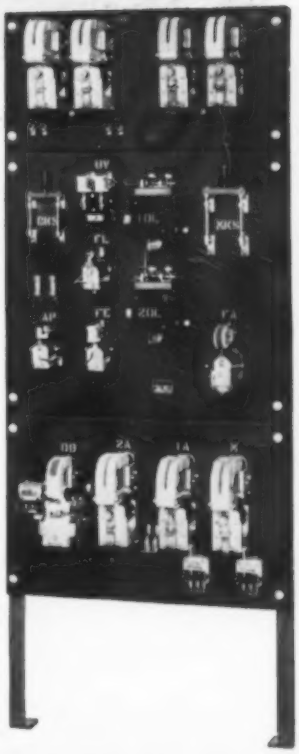
THE ELECTRICIAN—

Available with 1 to 6 points, reversing or non-reversing—1 to 12 circuits. Terminals, contacts and moving parts completely accessible. Generous wiring space.

Here's a mill duty controller to go with them

Specify both Square D master switches and mill duty controls on your next tough application. They are available for D. C. mill auxiliary and crane applications of all types.

Call your Square D Field Engineer or write for Bulletins 9003 (master switches) and 7950 (mill control). Address Square D Company, 4041 N. Richards St., Milwaukee 12, Wisconsin.



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DETROIT • MILWAUKEE • LOS ANGELES

SQUARE D COMPANY CANADA LTD., TORONTO • SQUARE D de MEXICO, S.A., MEXICO CITY, D.F.

Technique for Rolling Blooms and

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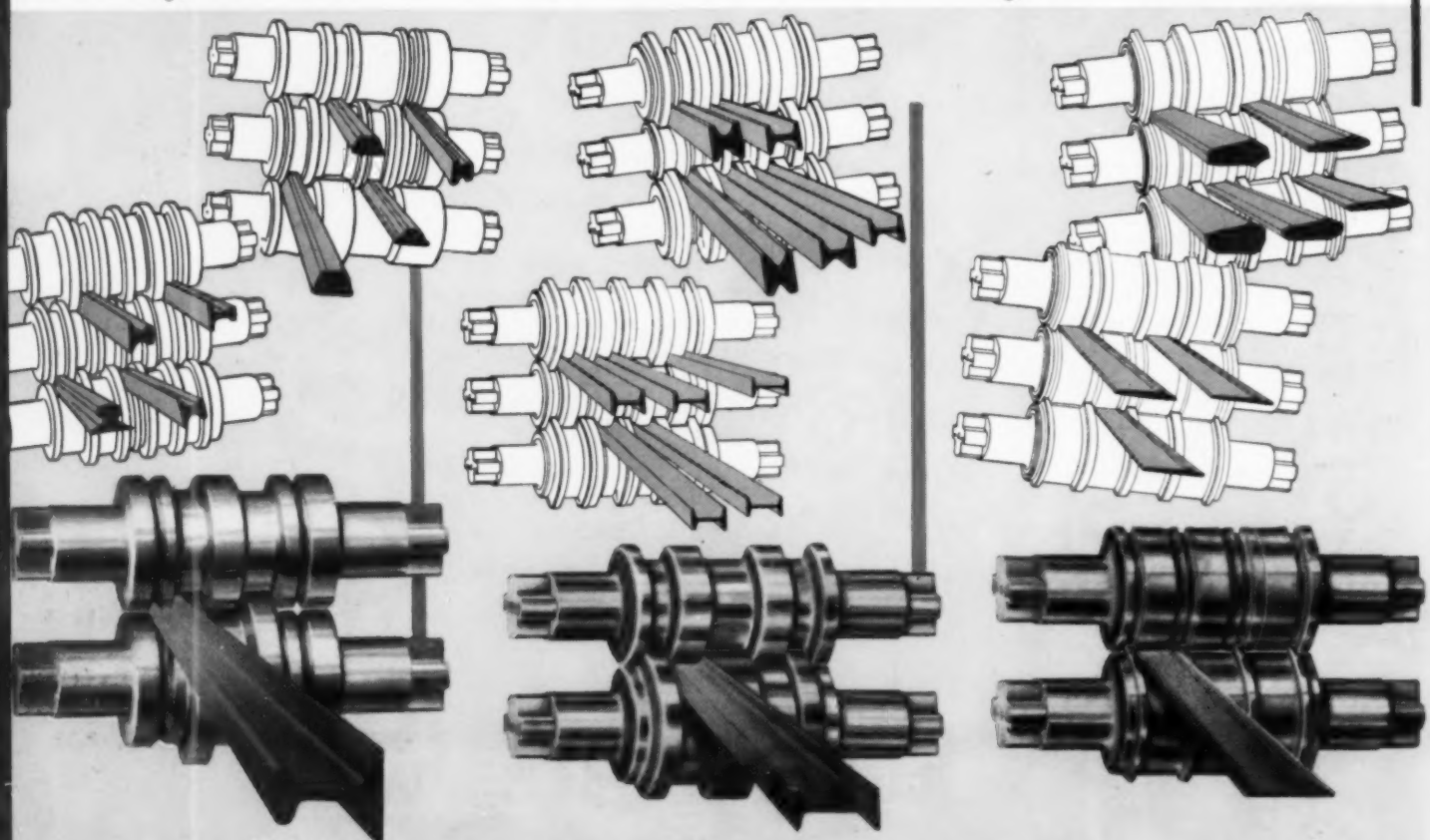

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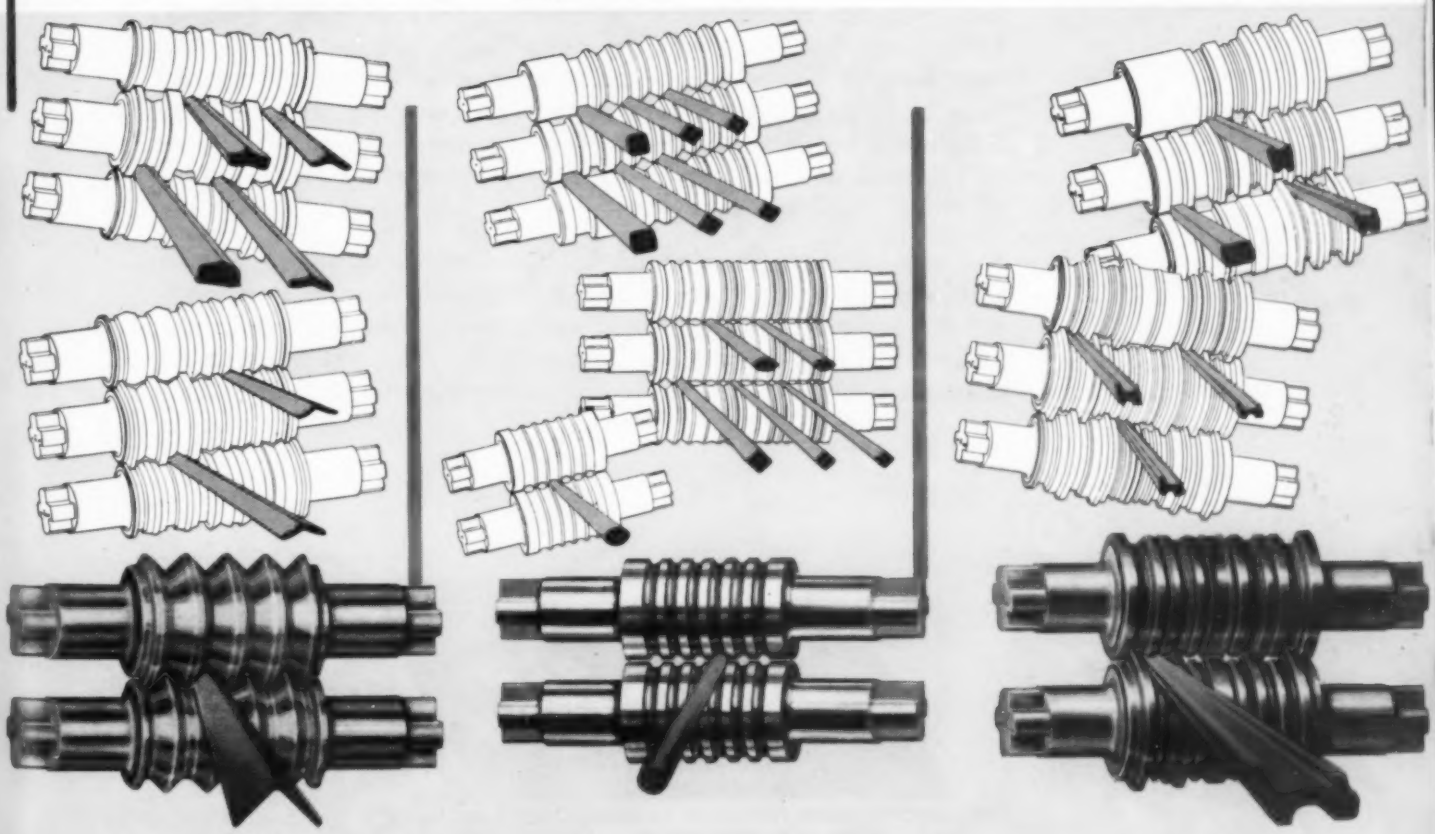
Billets into Finished Products...

There is a Phoenix Rol for every purpose, made to produce highest tonnages at *less cost per ton of steel rolled.*

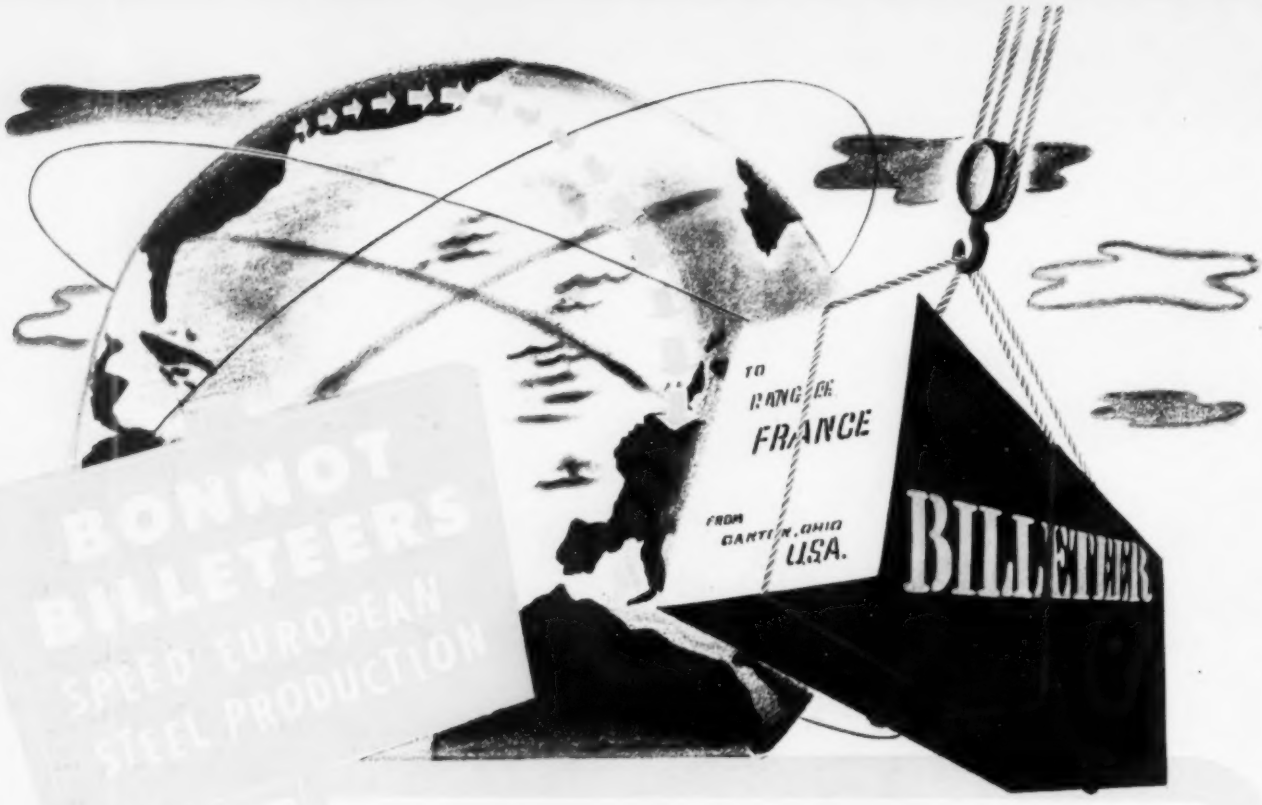
ANGLES BULB ANGLES Z BAR SPECIAL SHAPES ROUNDS RODS SQUARES SPLICE BARS



ROLLS

DIVISION OF BLAW-KNOX CO.

PITTSBURGH 1, PENNSYLVANIA



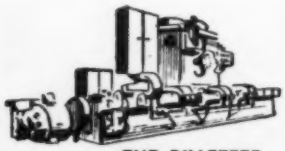
Still more Bonnot Billeteers are on the way to Europe to join those already speeding steel production for industrial recovery. Plants receiving the new Billeteers in the near future are located in Belgium, Luxemburg, Italy and France.

World-wide acclaim for the Billeteer lies in what the Billeteer is doing for every plant in which it is installed. The billet shed was once the bottleneck between furnaces and shipping docks. Today with Bonnot Billeteers, deep flaws can be cut out and remelting of billets is practically eliminated—there's a steady flow of clean billets to finishing mills. Operating records show a Billeteer handling 100 tons of billets per shift—removing up to 1½ tons of steel scrap—all flaws completely eliminated—all chips 100% reclaimable.

Just one operator handles the Billeteers easily during an 8-hour shift, doing the work of more than 10 hand chippers and without the fatigue and manpower turnover that results from more muscular methods of billet cleaning. Why not let the Bonnot Billeteer work for you? Write for information today!

Engineered for Improved Production

The Bonnot Co.
STEEL EQUIPMENT DIVISION
CANTON 2, OHIO



THE BILLETEER

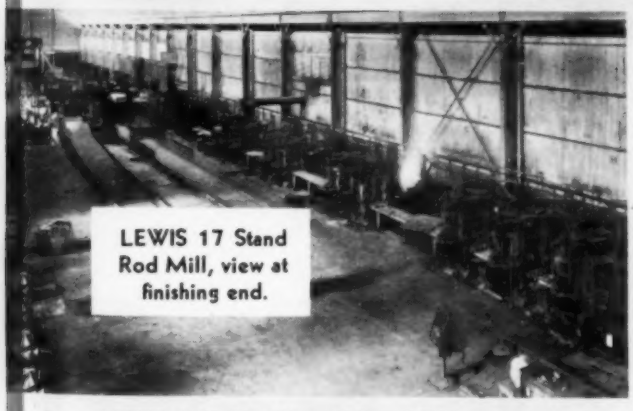
ALSO MANUFACTURERS OF SAWING · CRUSHING · PULVERIZING & MIXING EQUIPMENT
BILLET INSPECTION TABLES · DUST PUG MILLS SINTER PLANT PUG MILLS

LEWIS 22" x 44"
2-Hi Skin Pass Mill

LEWIS

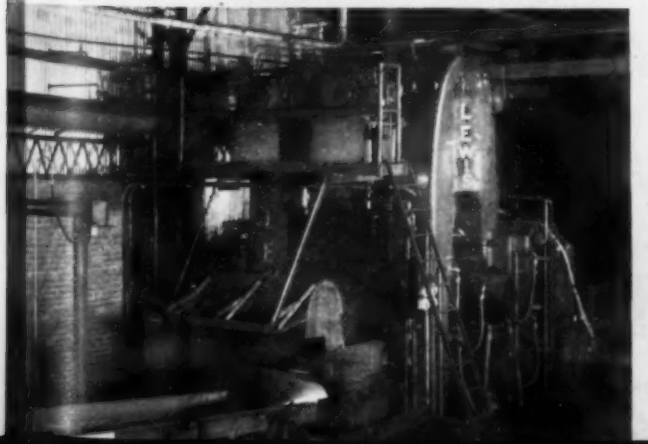
ROLLING MILL EQUIPMENT

...is recognized from coast to coast as the most modern.



LEWIS 17 Stand Rod Mill, view at finishing end.

LEWIS 3-Hi Roughing Mill and Tables



BEDS — Cooling
BLANKS — Gear • Pinion
BOXES — Coupling
CASTINGS — Rolling Mill Furnace
COILERS — Ferrous and Non-ferrous Strip
GEAR DRIVES
GEARS AND PINIONS — Bevel • Double Helical • Single Helical • Speed Reduction • Spur
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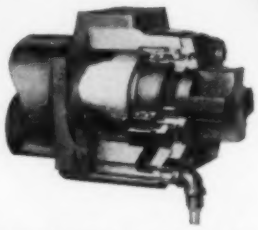
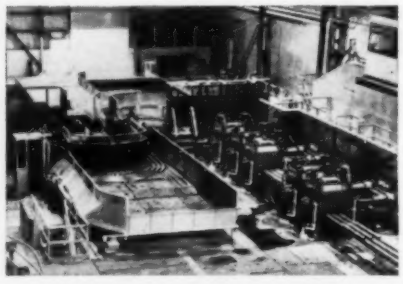


Morgoil Roll Neck Bearings

. . . will increase the accuracy of your product and save on operating and maintenance costs



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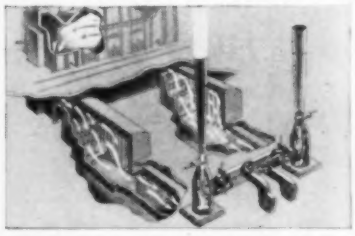
. . . built by specialists with over 60 years of pioneering in the field.

Wire Machines

. . . Morgan-Connors give high production, with low die cost, low power cost, low space requirement.



Furnace Control System

. . . Morgan-Isley increases efficiency of any regenerative furnace at relatively low installed cost.

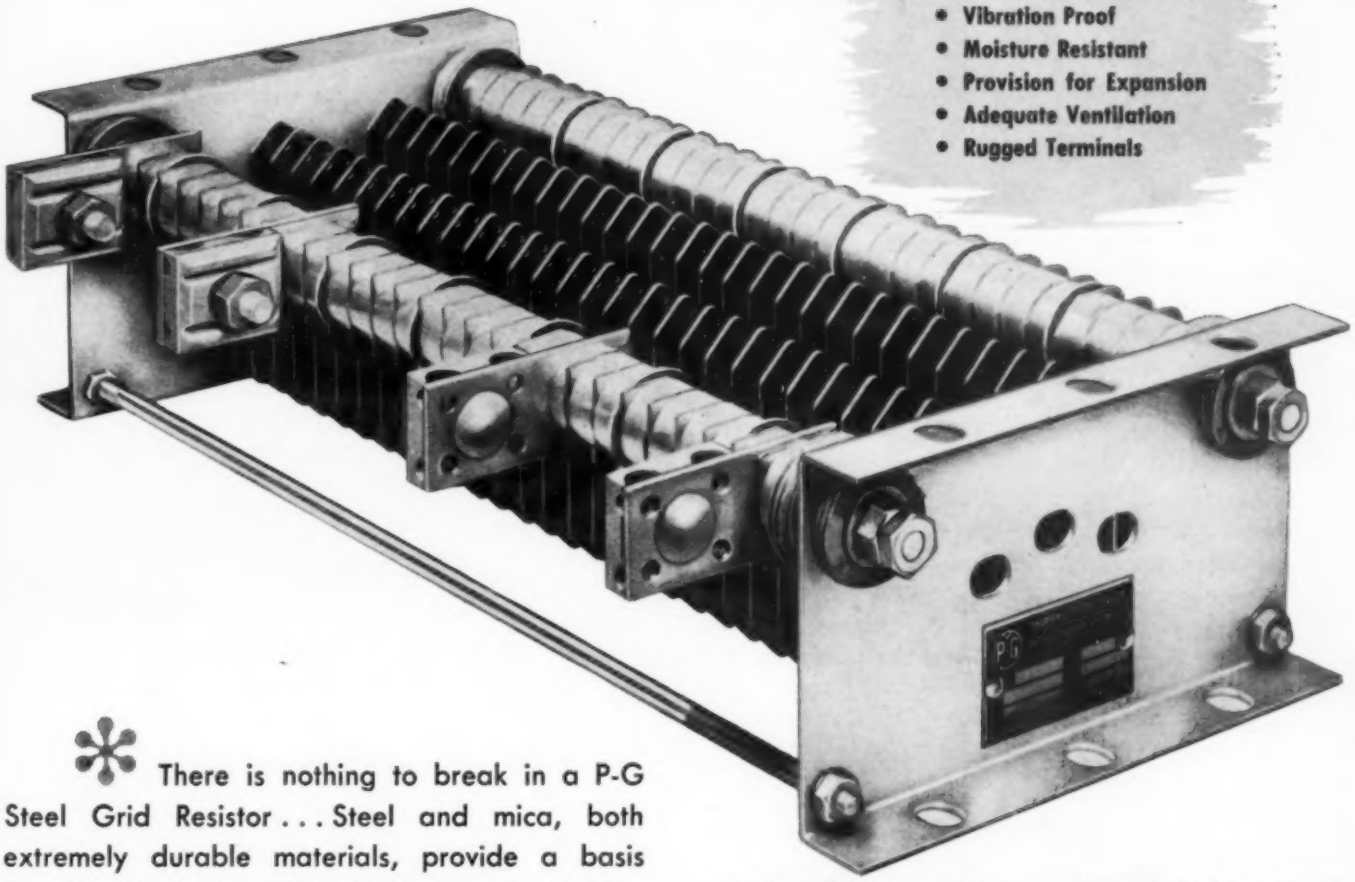
Air Ejectors

. . . efficiently handle hot gases and fumes as high as 3000° F.

BUILT OF *Steel* AND *Mica*

NOTHING TO BREAK . . .

- Steel Construction
- Mica Insulation
- Corrosion Resistant
- Vibration Proof
- Moisture Resistant
- Provision for Expansion
- Adequate Ventilation
- Rugged Terminals



There is nothing to break in a P-G Steel Grid Resistor . . . Steel and mica, both extremely durable materials, provide a basis for the utmost in mechanical strength. Neither do vibration, nor moisture laden or corrosive atmospheres have material effect on P-G Resistors . . . This, together with provision for expansion as well as efficiency in dissipating heat produced in operation, enables P-G Non-Breakable Resistors to give long and trouble-free service . . . The next time that troublesome application is at hand, specify P-G and solve your maintenance problem.

Write for Bulletin No. 500

P-G

The Nonbreakable Steel Grid Resistor

THE POST-GLOVER ELECTRIC COMPANY

• ESTABLISHED 1892 •

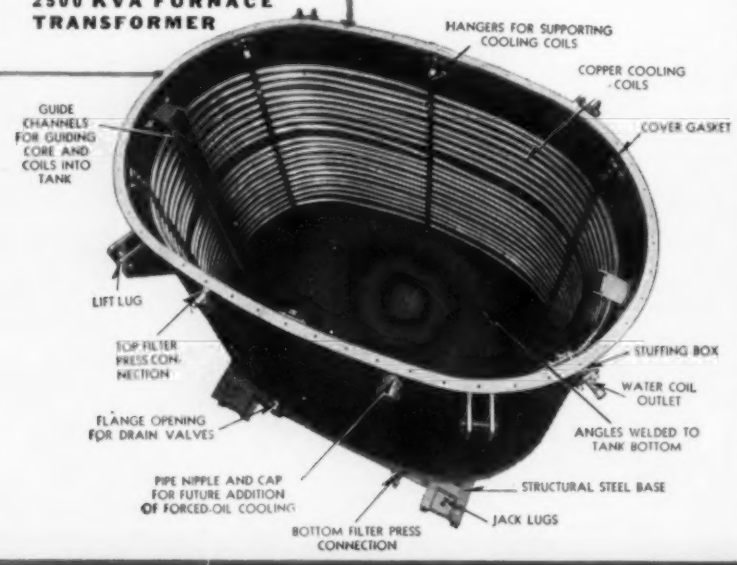
221 WEST THIRD STREET, CINCINNATI 2, OHIO

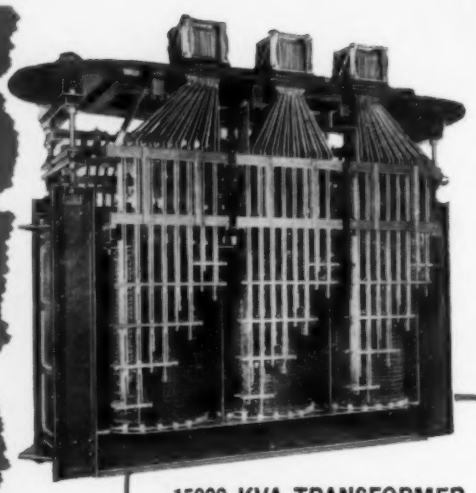
Over 1 MILLION KVA of Pennsylvania Furnace Transformers

Now in Service!

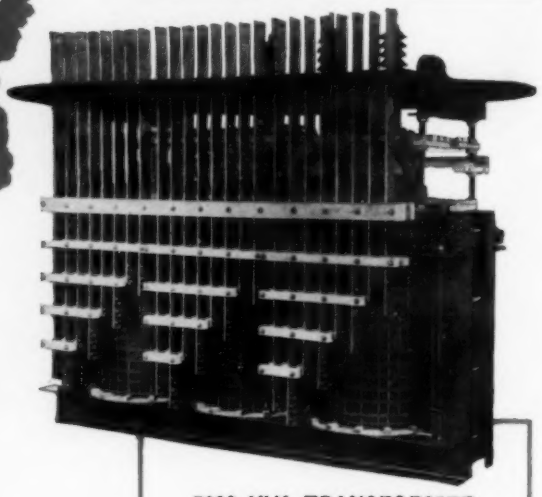
YES, Pennsylvania Furnace Transformers, totaling over 1 Million KVA, are supplying power to hundreds of electric furnaces. The successful operation of these transformers has given Pennsylvania Transformer Company a noted reputation in the Furnace Transformer field. For over 35 years, Pennsylvania Engineers have closely followed the development of Electric Furnaces. They fully understand the problems of Electric Furnaces and their relation to Furnace Transformers.

TANK INTERIOR OF 2500 KVA FURNACE TRANSFORMER

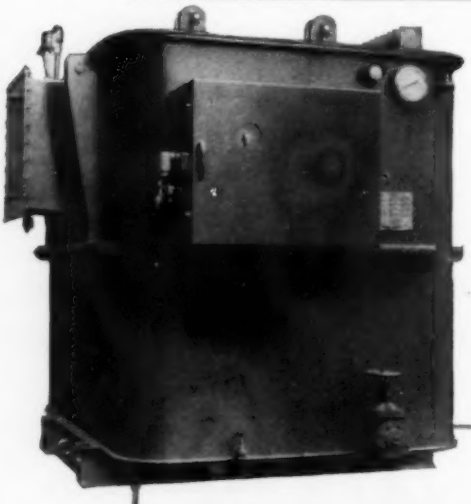

HANGERS FOR SUPPORTING COOLING COILS
COPPER COOLING COILS
GUIDE CHANNELS FOR GUIDING CORE AND COILS INTO TANK
COVER GASKET
LIFT LUG
TOP FILTER PRESS CONNECTION
STUFFING BOX
WATER COIL OUTLET
FLANGE OPENING FOR DRAIN VALVES
ANGLES WELDED TO TANK BOTTOM
PIPE NIPPLE AND CAP FOR FUTURE ADDITION OF FORCED-OIL COOLING
STRUCTURAL STEEL BASE
JACK LUGS
BOTTOM FILTER PRESS CONNECTION



15000 KVA TRANSFORMER
for operating a 75-Ton Furnace



5000 KVA TRANSFORMER
for operating a 15-Ton Furnace



7500 KVA TRANSFORMER
for operating a 30-Ton Furnace

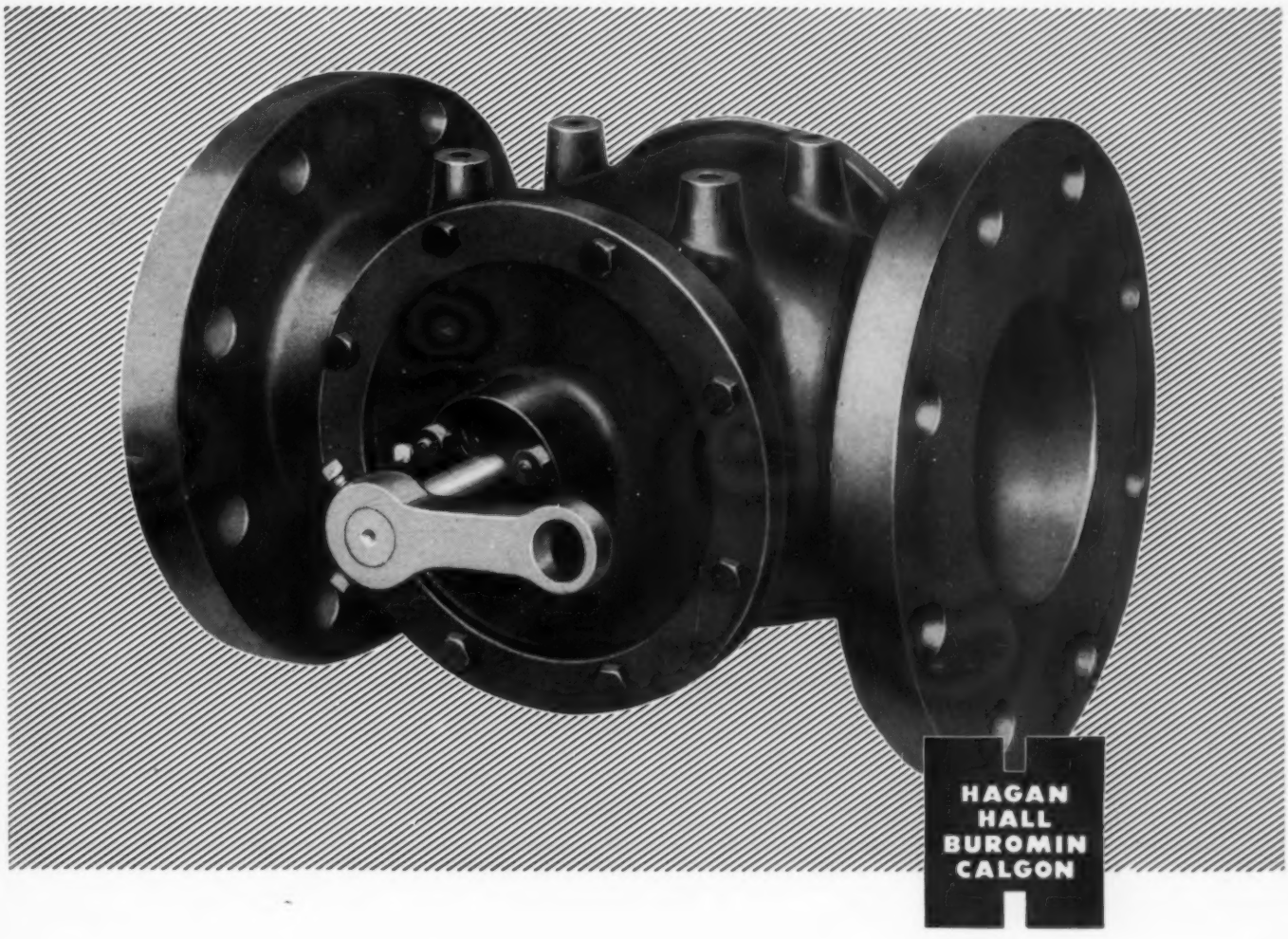
Pennsylvania TRANSFORMER COMPANY

Pennsylvania TRANSFORMERS

Furnace Transformer Experts

PITTSBURGH 12, PENNSYLVANIA

The Hagan V-Port Butterfly Valve



gives smooth, accurate regulation over the entire range of operation

Accurate proportioning of fuel and air is essential in the modern furnace, where heat input may vary over a turn-down range of 10 to 1. The need is particularly great at the low rates because at this time steel is up to temperature and most sensitive to furnace atmosphere.

At a minimum flow, the differential across regulating valves is usually the greatest. Losses across the measuring orifice, duct work and burner decrease, so that loss across the regulating butterfly must increase by a corresponding amount.

In the Hagan V-Port Butterfly Valve all of these factors are taken into account in port design, and smooth, accurate regulation is secured over the entire range of operation.

The shape of the ports in this valve is such that full advantage is taken of the inherent sensitivity and accuracy of regulating equipment.

Hagan V-Port Butterfly Valves are made in standard pipe sizes. They are ruggedly built and accurately machined. Our engineers will be glad to give you full information.

Hagan Corporation, Hagan Building, Pittsburgh 30, Pa.

HAGAN CORPORATION

BOILER COMBUSTION CONTROL SYSTEMS
RING BALANCE FLOW AND PRESSURE INSTRUMENTS
METALLURGICAL FURNACE CONTROL SYSTEMS
THRUSTORQ FORCE MEASURING DEVICES

all-electric 54" continuous annealing and galvanizing line —boosts output of uniform-quality heavy gage steel!

General Electric engineered furnace and drive handles gages up to .125 thick . . . speeds as high as 120 fpm . . . for a 13-tons-per-hour capacity!

Here's a case where General Electric engineered both the annealing furnace and the line drives for a new 54" continuous annealing and galvanizing line to process heavy-gage strip in a large Pennsylvania steel mill.

Handling gages up to .125 thick, the line employs amplidyne regulators and photo-electric loop controls to synchronize the strip speed and tension with furnace requirements and give smooth, rapid acceleration and deceleration from 8 to 120 fpm.

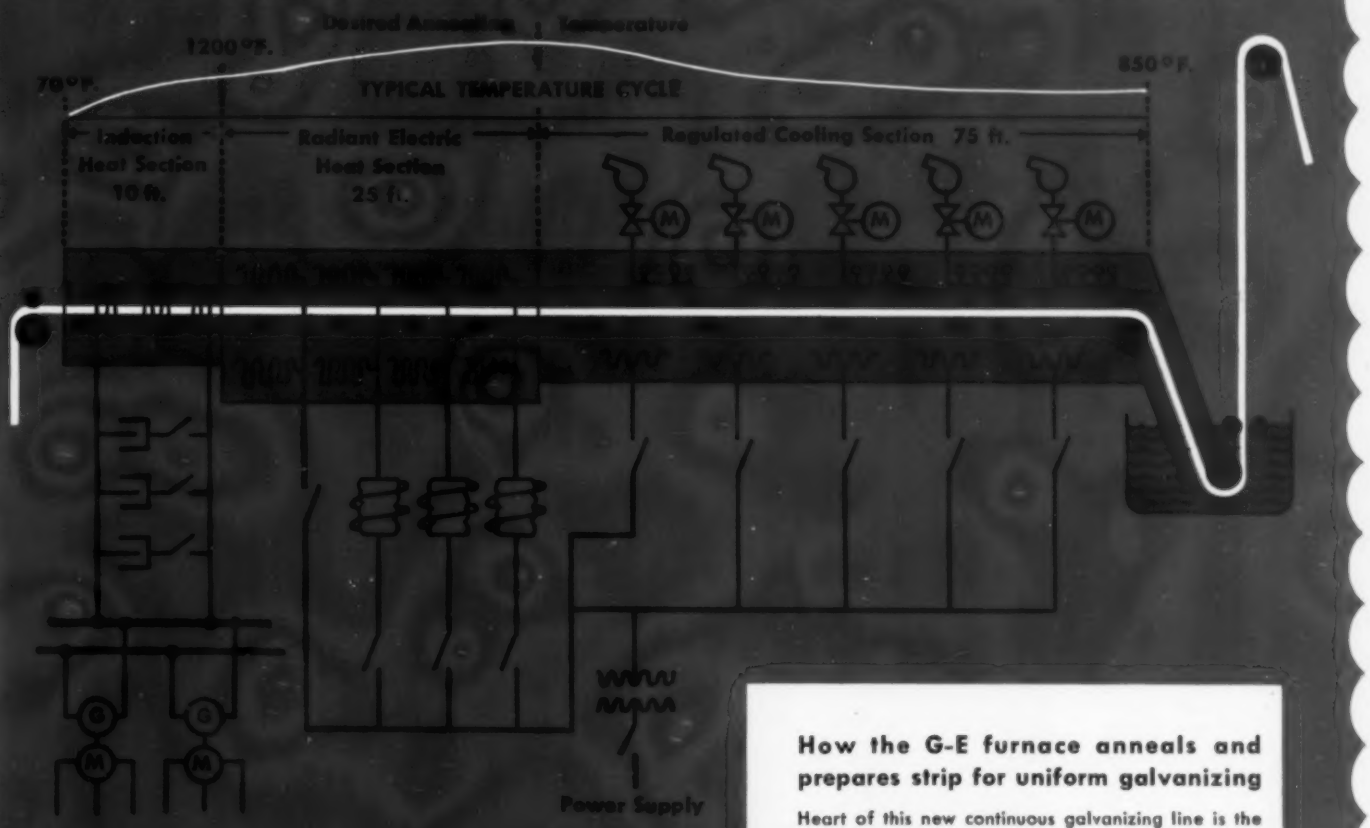
With the G-E roller-hearth electric furnace, the mill operators are assured of

- Accurately regulated temperatures which provide close control over the finished sheet's hardness and drawability
- Close control of the furnace's protective atmosphere, which eliminates the necessity of additional pickling to clean the strip
- Surface preparation that makes possible a uniformly-thick, tightly-adhering zinc coating which improves corrosion resistance and permits relatively deep drawing
- Continuous annealing process that permits greater output than with former batch methods

Whatever the right solution to your steel mill problem, you'll find it faster, easier, and at less cost when a G-E steel-mill specialist teams up with your technical staff. Call him at your nearest G-E office, listed in your classified phone directory. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

GENERAL ELECTRIC

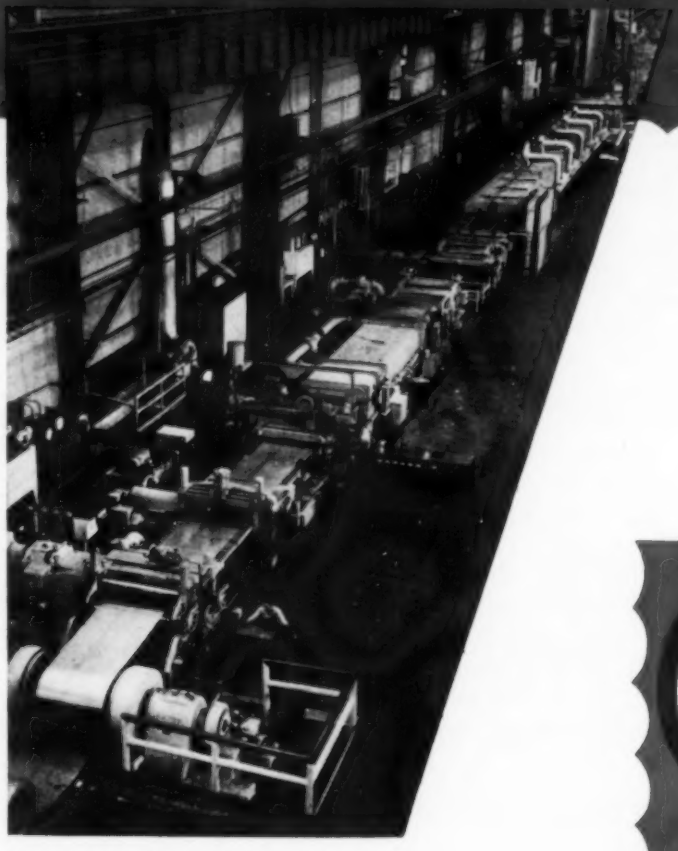
659-72



How the G-E furnace anneals and prepares strip for uniform galvanizing

Heart of this new continuous galvanizing line is the G-E roller-hearth annealing furnace (just ahead of the galvanizing pot), which can handle steel strip from .05" to .125" thick and from 24" to 54" wide. Furnace length is considerably reduced by a 10-foot induction heating section, which uses 1400 kva of 9600-cycle power to heat the strip to 1200 degrees F. For further heating to annealing temperature, the strip enters a 375-kw, 25-foot electric furnace, most of which is automatically regulated by G-E Reactrol control. The strip then undergoes regulated cooling to 850 degrees F in a 75-foot cooling chamber.

During heating, the strip is exposed to a highly-reducing protective atmosphere that prepares its surface for galvanizing. Once prepared, the steel is further safeguarded, until it is zinc-coated, by a protective atmosphere in the cooling chamber. The furnace and its control provide great flexibility in control of temperature and of rate and degree of cooling, plus accurate regulation of the protective atmosphere.



G-E roller-hearth electric furnace (far end), plays big part in continuous wide-strip galvanizing on this 500-foot line. Its fast-acting induction preheating section speeds up heating, saves space in the line.

another example of GENERAL ELECTRIC drive engineering at work!

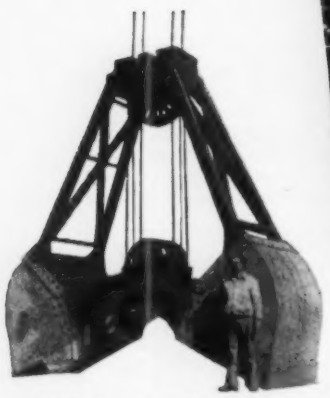
Wellman will build it

Special Cranes
Ore Bridges
Gas Producer Plants
Charging Machines
Industrial Furnaces
Car Dumpers
Gas Flue Systems
Gas Reversing Valves
Coke Pushers
Mine Hoists
Skip Hoists
Clamshell Buckets

Wellman Ore and Coal Handling Bridges

For fast and efficient action

One of two 6-ton Coal Handling Bridges in this installation.



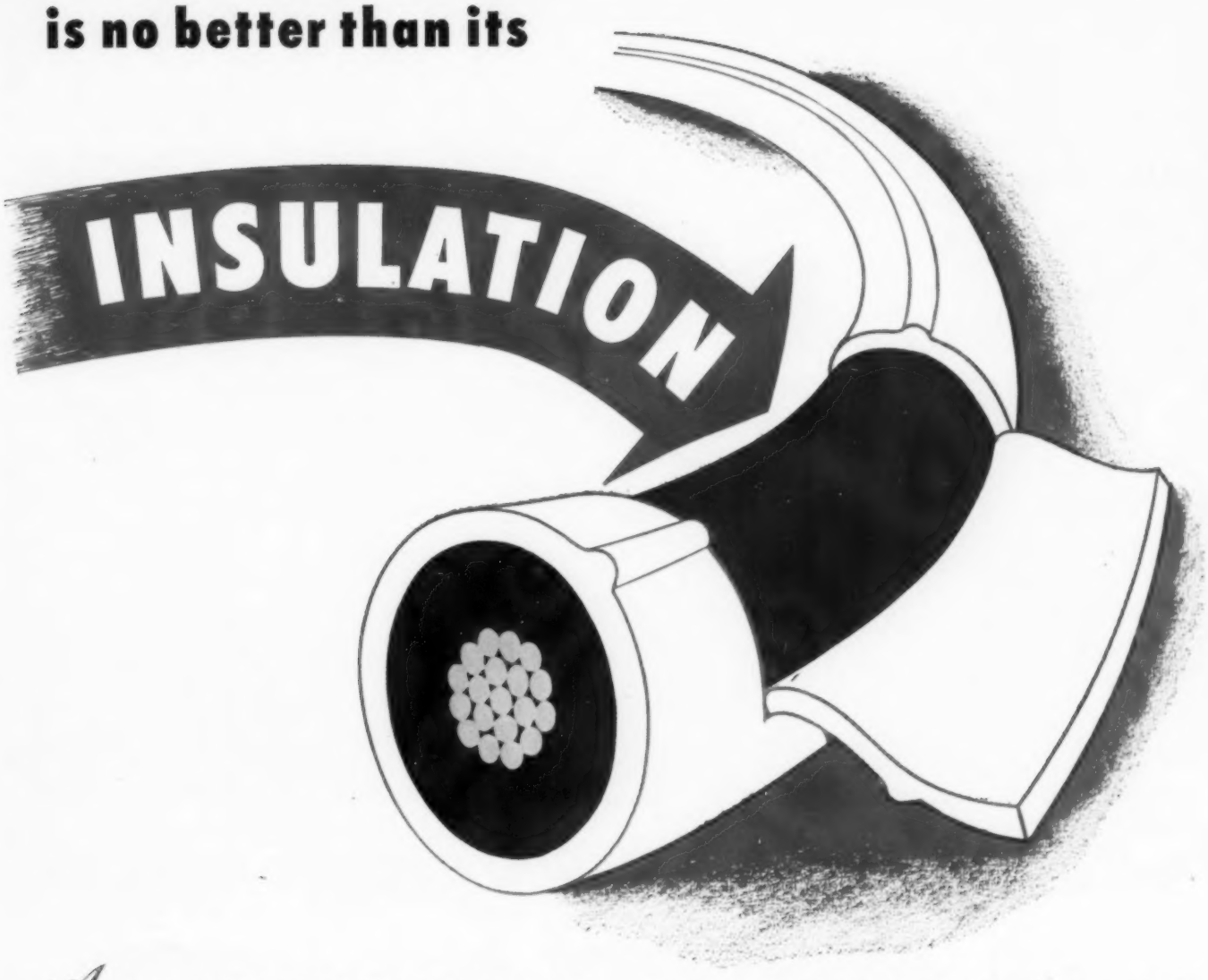
6-ton Wellman Williams Type Coal Bucket used with these bridges.

• Take advantage of Wellman's long experience in designing and building handling bridges in many types and capacities. Your selection from the complete line will provide fast and efficient handling of coal or ore.

THE WELLMAN ENGINEERING COMPANY

7031 CENTRAL AVENUE • CLEVELAND 4, OHIO

an electrical cable is no better than its



An electrical cable is only as efficient and long-lasting as its insulation. You will find true cable economy *only* in the cable with the best insulation. Because electrical insulation is so vital to cable performance, it is important to know what makes one type of insulation better than another.

There are three basic factors determining the electrical and mechanical characteristics of rubber cable insulation.
1. The type and grade of rubber used in the compound.
2. The method of applying the insulation to the cable.
3. The method of vulcanizing the insulation.

In Okonite insulations, each of these three points is a reason for superior performance. First, Okonite uses only Wild Up-River Fine Para rubber – the very finest obtainable – because this rubber has proved during more than 70 years of actual use to have better dielectric and aging qualities than any other.

Second – the unique Okonite strip method of applying insulation assures absolute uniformity of wall thickness . . . perfectly centered conductors. This advantage, guaranteed only by the strip method, is another reason for the famous long life and dependability of Okonite-insulated cables.

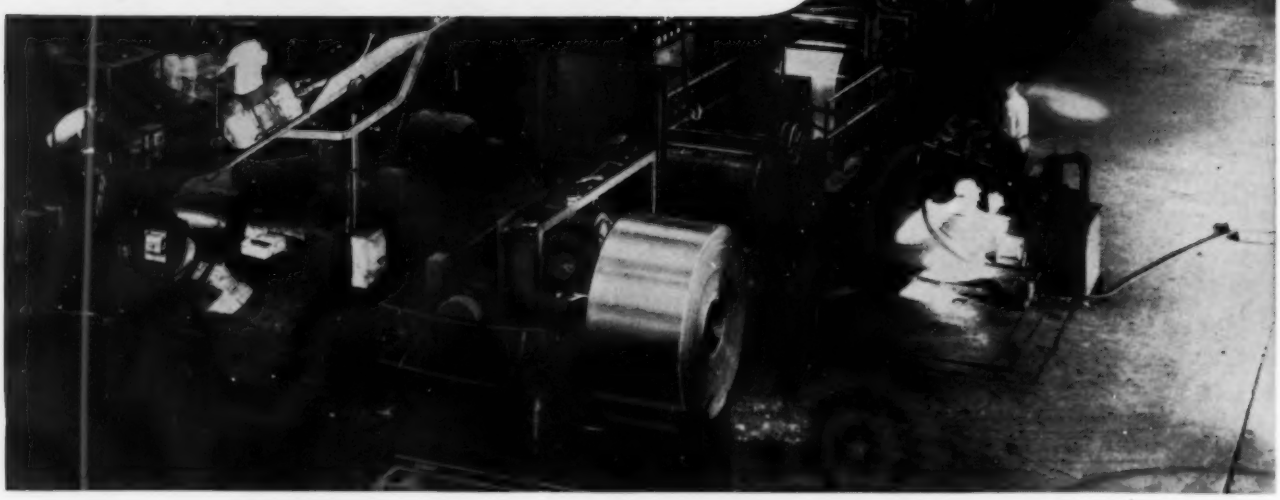
Third – after the insulation has been applied by the strip method, it receives a *single* vulcanization in a continuous tin mold, under high pressure. Advantages of this exclusive process are an insulation of higher density, greater physical and electrical uniformity.

Years of operation under widely varied conditions – the most convincing test of all – *prove* the longer life and more dependable performance you obtain from an Okonite insulation. The Okonite Company, Passaic, N. J.

8107

THE BEST CABLE IS YOUR BEST POLICY

OKONITE SINCE 1878 *insulated wires and cables*



Strip comes clean at *1500 feet per minute* with OSBORN power driven brushes

ON the continuous scrubbing operation above, 6 Osborn Heli-Master* Brushes are mechanically cleaning strip steel at speeds of over 1500 feet per minute. This vital mill operation is removing all traces of rolling oil from the strip prior to electrolytic tin plating.

Heli-Master Brushes can be supplied with the correct material to do tough cleaning jobs well. In the job illustrated, the operating conditions include high pressure hot sprays. The brushes give around-the-clock dependable performance. They are helping assure continuous, uninterrupted production schedules by maintaining consistent high quality of finished products.

If you have a continuous strip cleaning, sheet scrubbing, scale removing, bonderizing or conveyor cleaning problem, it is likely that it can now be done easier, faster and at lower cost with new improved Osborn brushing techniques. Why not consult your Osborn representative. Call or write—

THE OSBORN MANUFACTURING COMPANY

Dept. 262 5401 Hamilton Avenue • Cleveland 14, Ohio

* Trademark

Osborn Brushes

WORLD'S LARGEST MANUFACTURER OF BRUSHES FOR INDUSTRY • POWER DRIVEN BRUSHES • PAINT BRUSHES • MAINTENANCE BRUSHES

"TOOL STEEL" PROCESS

TRACK WHEELS FOR OVERHEAD CRANES...

provide

YEARS OF SERVICE AS COMPARED TO MONTHS FOR OTHER MATERIALS!

"Tool Steel" track wheels are providing up to **30 times** the life of ordinary wheels used in the same service!

This amazing superiority is substantiated by our customers' own records.

Investigate these **facts** today. You'll find the same unequalled quality built into other "Tool Steel" parts for cranes, including gears, pinions, brake and sheave wheels, axles and sheave pins!

WE GUARANTEE our products to give sufficient life over any other grade of hardened material operating in the same service to cover any difference in first cost. If our material fails to fulfill this guarantee, we will make good the deficiency in either cash or new material.

THIS GUARANTEE WAS ORIGINATED BY AND IS EXCLUSIVE WITH THE TOOL STEEL GEAR AND PINION CO.

HERE'S AN ACTUAL COMPARISON:

(From the customer's own records:)

WHEELS	AVERAGE LIFE IN MONTHS
High carbon cast	8 to 12
Manganese steel	12 to 18
Hardened rolled steel	16 to 20
"TOOL STEEL"	**over 168***

*After **14 YEARS** of service further records were deemed unnecessary.

This service life can be equalled by no other products!

Write today for complete information.

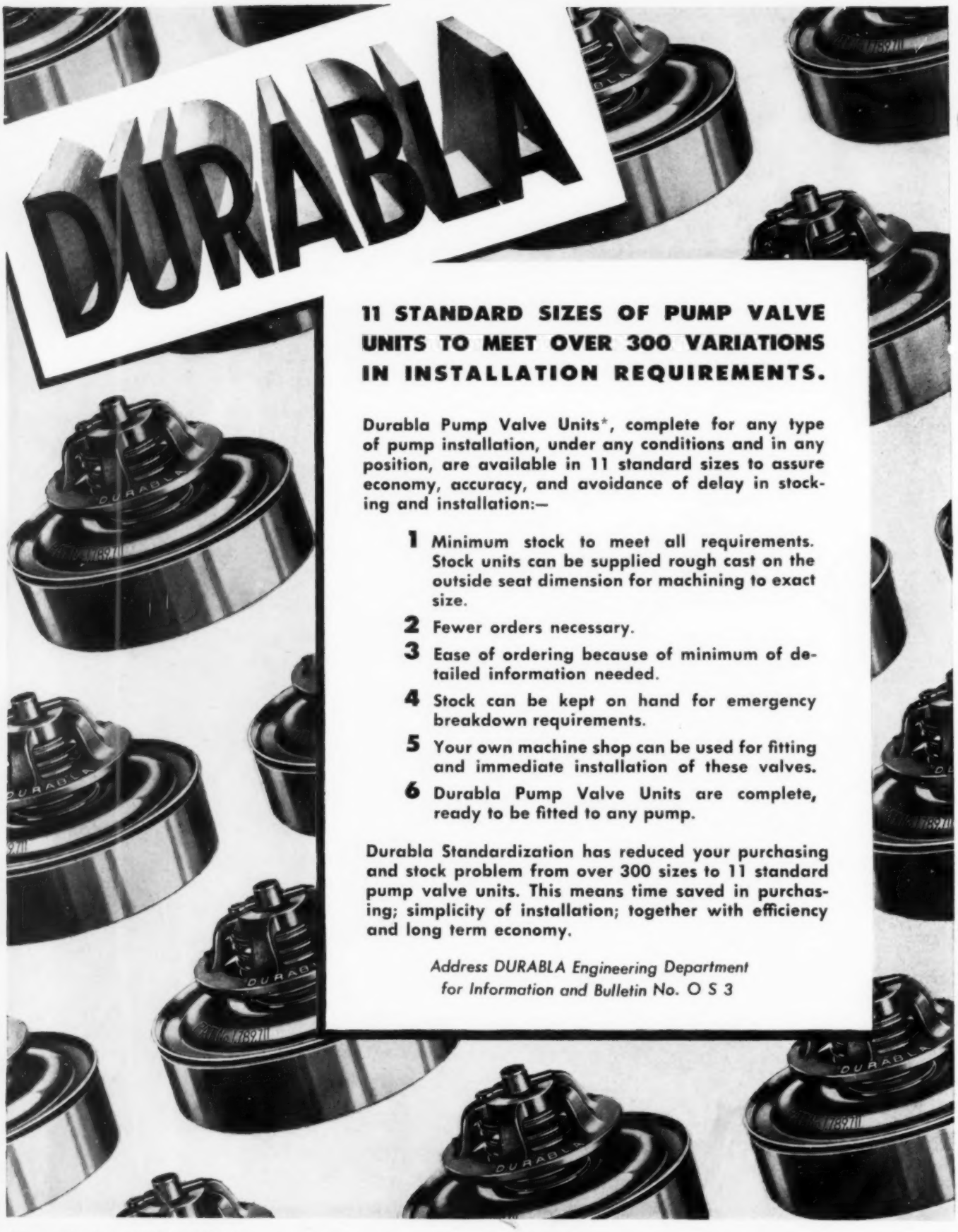
"TOOL STEEL" PROCESS

The Standard of Quality

for GEARS • PINIONS • ROLLS • WHEELS *and other* HARDENED PRODUCTS

THE TOOL STEEL GEAR & PINION CO.

CINCINNATI 16, OHIO, U. S. A.



11 STANDARD SIZES OF PUMP VALVE UNITS TO MEET OVER 300 VARIATIONS IN INSTALLATION REQUIREMENTS.

Durabla Pump Valve Units*, complete for any type of pump installation, under any conditions and in any position, are available in 11 standard sizes to assure economy, accuracy, and avoidance of delay in stocking and installation:—

1. Minimum stock to meet all requirements. Stock units can be supplied rough cast on the outside seat dimension for machining to exact size.
2. Fewer orders necessary.
3. Ease of ordering because of minimum of detailed information needed.
4. Stock can be kept on hand for emergency breakdown requirements.
5. Your own machine shop can be used for fitting and immediate installation of these valves.
6. Durabla Pump Valve Units are complete, ready to be fitted to any pump.

Durabla Standardization has reduced your purchasing and stock problem from over 300 sizes to 11 standard pump valve units. This means time saved in purchasing; simplicity of installation; together with efficiency and long term economy.

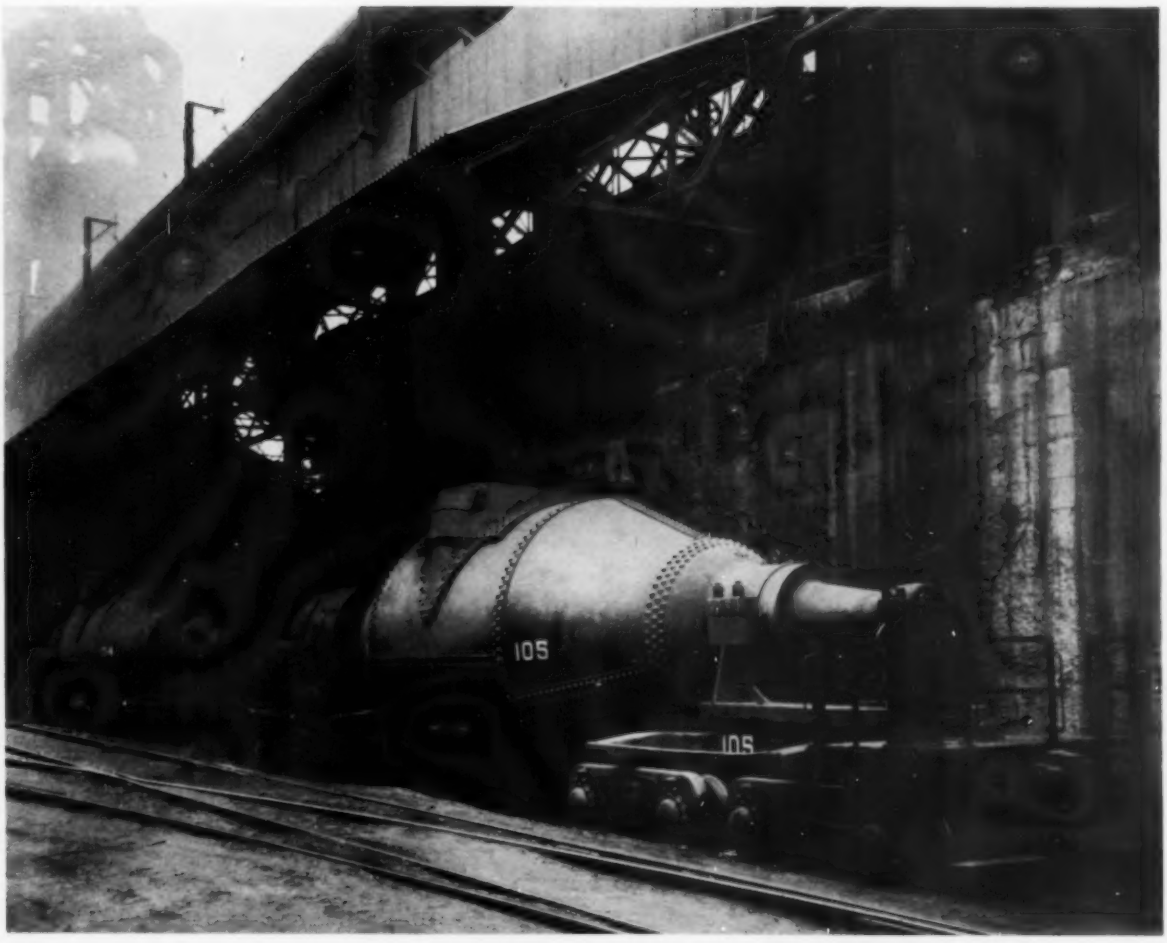
Address DURABLA Engineering Department for Information and Bulletin No. O S 3

*Patent Numbers 2090486, 2117504

DURABLA MANUFACTURING COMPANY
114 LIBERTY ST. NEW YORK
BRANCHES IN PRINCIPAL CITIES. FOR CANADA REFER: CANADIAN DURABLA LIMITED, TORONTO

TREADWELL

MIXER TYPE HOT METAL CARS
REDUCE
OPERATING COSTS



BUILT IN CAPACITIES TO MEET YOUR REQUIREMENTS

75 to 210 Net Tons

279 OF THESE CARS NOW SERVE THE STEEL INDUSTRY

M. H. TREADWELL CO., INC.

208 S. LA SALLE ST.
CHICAGO 4, ILL.
CEntral 6-6784

140 CEDAR STREET
NEW YORK 6, N. Y.
WOrth 4-2244

1217 FARMERS BANK BLDG.
PITTSBURGH 22, PA.
ATlantic 1-2303

Loading up...FOR A 40% SAVING

CUT UP TO $200,000 A YEAR FROM REFUSE DISPOSAL COSTS

From Open Hearth to Dump and back again. That can be a costly operation or just a normal operating expense.

It all depends on the equipment used.

Gondola, hopper or obsolete air dump cars run the cost of refuse disposal way up out of sight. They're not built for the job. The heat of lading and banging of buckets makes maintenance and repair quite a sizeable item on your annual budget. On top of that, there's added labor costs, loss of operating time and haulage waste due to inefficient equipment.

Here's how you can bring those costs down within reach and maintain an even higher degree of operating efficiency – New Magor Air Dump Cars – built specifically for steel plant service.

New Magor Air Dump Cars are a modern low-cost approach to refuse disposal. They can take the roughest treatment year in and year out with a minimum of maintenance expense. Through labor and maintenance savings alone, you can write off your entire investment within a few years.

COST LESS THAN $1.35 A DAY

That's all it costs to own a 30 yd. 70 ton Heavy Duty Steel Plant Magor Air Dump Car – *dump cars that can cut your refuse disposal costs as much as 40%.*

The New **MAGOR** *Steel Plant Air Dump Car*

Write today for your copy of the new brochure, "The Answer to High Refuse Disposal Costs." This well-illustrated brochure explains, in detail, the many money-saving advantages of owning Magor Air Dump Cars.

MAGOR CAR CORPORATION · 50 CHURCH ST., NEW YORK 7, N. Y.

CLARK CONTROL and BLISS 3-stand, 2-high MILL combine ACCURACY and CAPACITY

- Top illustration shows BLISS 3-stand, 2-high mill for accurate cold rolling crown-rolled strip.
- Middle illustration shows CLARK Bulletin 9380 3-stand, 2-high variable voltage tandem-mill and reel control.
- Bottom illustration shows A.C. Screw-down control.

This mill in a mid-west steel plant, provides a single pass 50% average reduction; cold-rolling and finishing of stainless and spiral alloys within .001" overall accuracy; round-the-clock operation at speeds up to 600 ft. per minute.

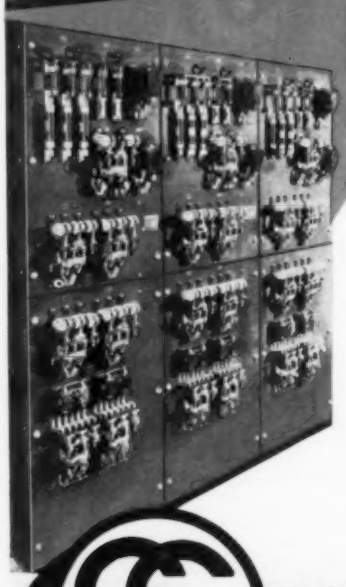
Close tolerance precision wire rolling, such as bearing racer stock and crown-rolled strip, is kept at extreme capacity by sturdy construction, with all fitted parts precision machined, combined with controlled tension on wind-up reels, and electrically controlled screw-downs providing rapid adjustment.

Clark Bulletin 9380, 3-stand 2-high variable voltage tandem-mill and reel control, is shown left above. Control is provided for

3 — 150 HP, 690/1400 RPM Mill Motor	1 — 30 KW Reel Generator
1 — 30 HP, 300/1200 RPM Reel Control	1 — 15 KW Exciter Generator
1 — 400 KW Mill Generator	1 — 1 KW Tachometer Generator

The three screw-down control panels, left below, are each for use with two 5 HP, 440 V, 3 ph, 60 cy. squirrel cage screw-down motors and one 230 V, DC Clutch.

For accurate, dependable electrical control, put your problems up to CLARK engineers. They're as close to you as your 'phone.



THE CLARK CONTROLLER CO.

ENGINEERED ELECTRICAL CONTROL • 1146 EAST 152ND STREET, CLEVELAND 10, OHIO

In the Nation's Iron and Steel mills . . .

HARBISON-WALKER REFRACTORIES

Dependable Aids to Economical Operation

For every refractory requirement in the iron and steel industries, Harbison-Walker products are used—in blast furnaces, coke ovens, open hearth and electric steel furnaces, transfer ladles, holding, heating, heat-treating and forge furnaces.

The outstanding records made by Harbison-Walker refractories are due to the high quality of the products, the full complement of types and classes, the wide variety of shapes, and the correct technical application.

Through the services of its Technical Department, Harbison-Walker stands ready to assist in the selection and application of refractories that will serve dependably and economically in every kind of furnace.

For dependable performance in every steel-making operation

Blast Furnace Refractories

Harbison-Walker has furnished the majority of blast furnace refractories used in the United States—and many world's records have been made with Harbison-Walker linings.

H-W BENEZET & H-W KENTUCKY BLAST FURNACE LININGS—For years the standard for all sizes and designs of furnaces under every set of operating conditions. For Hearth and Bosh, Inwall and Top linings.

H-W 18—Because of its high resistance to disintegration by carbon monoxide gas, H-W 18 is the outstanding refractory for complete linings. It provides low permeability and porosity, constancy of volume at high temperatures, excellent mechanical strength and high resistance to abrasion.

H-W MORTARS—Best results are obtained when Harbison-Walker cold-setting bonding mortars, Harwaco Bond or Thermolith, are used for laying the brick. H-W Bond B Clay is also widely used for laying the brick in the lining.

H-W BLAST FURNACE STOVE BRICK—Dense, strong, high-duty H-W Stove Brick are used for domes, combustion chambers and checkers. Highly resistant to severe fluxing conditions.

Open Hearth Refractories

STAR SILICA—Used for construction and maintenance of roofs and other sections of the furnace. Significant characteristics: high refractoriness, rigidity under load at high temperatures, good resistance to spalling, abrasion, and fluxing.

VEGA—The super-duty, high temperature silica brick for roofs, renders longer service and is especially suited for extremely severe operating conditions.

VEGA BOND—Super-duty silica bonding mortar of excellent workability and super-duty refractoriness; thermal expansion entirely compatible with that of silica brick.

H-W MAGNAMIX—A magnesite ramming mixture for complete monolithic bottoms and patching. Easily installed . . . adheres to steepest banks.

CHROMEX B—Extremely hard burned chrome-magnesite brick with excellent volume stability and great strength at high temperatures, for port roofs, front walls, back walls and sections of the port ends.

METALKASE—A chemically bonded magnesite-chrome brick encased on three sides in steel containers. Used extensively for front walls, end walls, back walls, and roof shoulders.

H-W MAGNESITE—A hard burned magnesite refractory for bottoms, lower front and back walls and ports.

H-W CHROME—A hard burned chrome brick for furnace bulkheads.

Harbison-Walker Refractories Company
and Subsidiaries

WORLD'S LARGEST PRODUCER OF REFRACTORIES

PITTSBURGH 22, PENNSYLVANIA

TRADE MARK
REG. U.S. PAT. OFF.

. . . use HARBISON-WALKER specialized refractories

Electric Furnace Refractories

STAR SILICA—Used in roofs and side walls of basic electric steel furnaces; in roofs, sidewalls and bottoms of acid electric steel furnaces.

VEGA—Withstands higher temperatures, gives longer life, reduces maintenance costs; the original super-duty silica brick.

METALKASE—A chemically bonded metal-encased magnesite-chrome brick. Dense, strong, and homogenuous in structure. Metalkase has the high refractoriness and slag resisting qualities of basic brick, with superior resistance to spalling. In basic electric furnace sidewalls, they have given double the life secured from other basic brick and up to ten times the life of silica brick.

ALCOR XX—High alumina brick of the 60% alumina class for roofs. High refractoriness, low porosity, stability of volume and rigidity under load at high temperatures and exceptionally good resistance to thermal spalling.

For Other Steel Mill Applications

For the many and varied heat applications in the modern steel mill, Harbison-Walker provides refractories which meet every need. Some of these refractories are:

High Alumina brick of all classes—from 50% to 90% alumina inclusive.

Super-Duty Fireclay refractories—**Vernon, Alamo, Kenmore, Boone** and **Dean.**

All other classes of fireclay refractories.

Insulating fire brick of all classes.

Duro Acid Proof brick and tile.

Forsterite Refractories.

High temperature bonding mortars and ramming mixtures of all types.

Plastics and **Castables**—Standard, Super-duty and Light-weight.

Complete data on these and other Harbison-Walker products will be gladly furnished upon request.

LUBRICATION DAN SEZ:

We're not from Missouri but Our customers are!

WE'VE HAD TO PROVE THE OUTSTANDING PERFORMANCE OF * LEADOLENE

Klingfast

CHECK THESE 9 IMPORTANT FACTS

1. **EXTREME PRESSURE pH-ilm STRENGTH of 50,000 lbs. per square inch minimum by "Timken" testing machine.**
2. **ADHESIVENESS in which affinity for steel and other metals develops maximum adhesion and prevents drippage or creeping. Retains a flexible coating in nature.**
3. **WATER REPELLENCE which retards washing off, creates a lubricating pH-ilm under moisture or water conditions.**
4. **CORROSION PREVENTION is an excellent protective coating in that it will not etch or corrode metals. Is never acidic.**
5. **COMPOUNDED STABILITY—Will not bleed or change physical condition within range of higher than usual temperatures for this type of lubricant.**
6. **LOW TEMPERATURE FACTORS—While having a solidifying action by decreased temperature as low as —40 F., it does not harden, crack or decrease in adhesion. The flexible coating withstands distortion of the application.**
7. **ABRASIVE RESISTANCE—Extremely high for a lubricant. Does not wipe off nor will be removed in handling by workmen's hands or gloves. Is extremely repellent to adhesion of scale, metallics and other forms of dusts or contamination.**
8. **Klingfast has remarkable corrosive resistance to salt or sea water, acidic vapors and solutions.**
9. **Klingfast can be removed by ordinary solvents such as kerosene, gasolene, naphtha, carbontetrachloride and similar substances but is highly impervious to lubricating oils and greases.**

***LEADOLENE . . . the "I. P. Lubricant" (Indestructible pH-ilm) . . . for Industrial Needs**

We've never sold an ounce of lubricant the easy way—for instance: a major steel plant told us they were "from Missouri" about the outstanding characteristics and performance claims we made on Leadolene KLINGFAST.

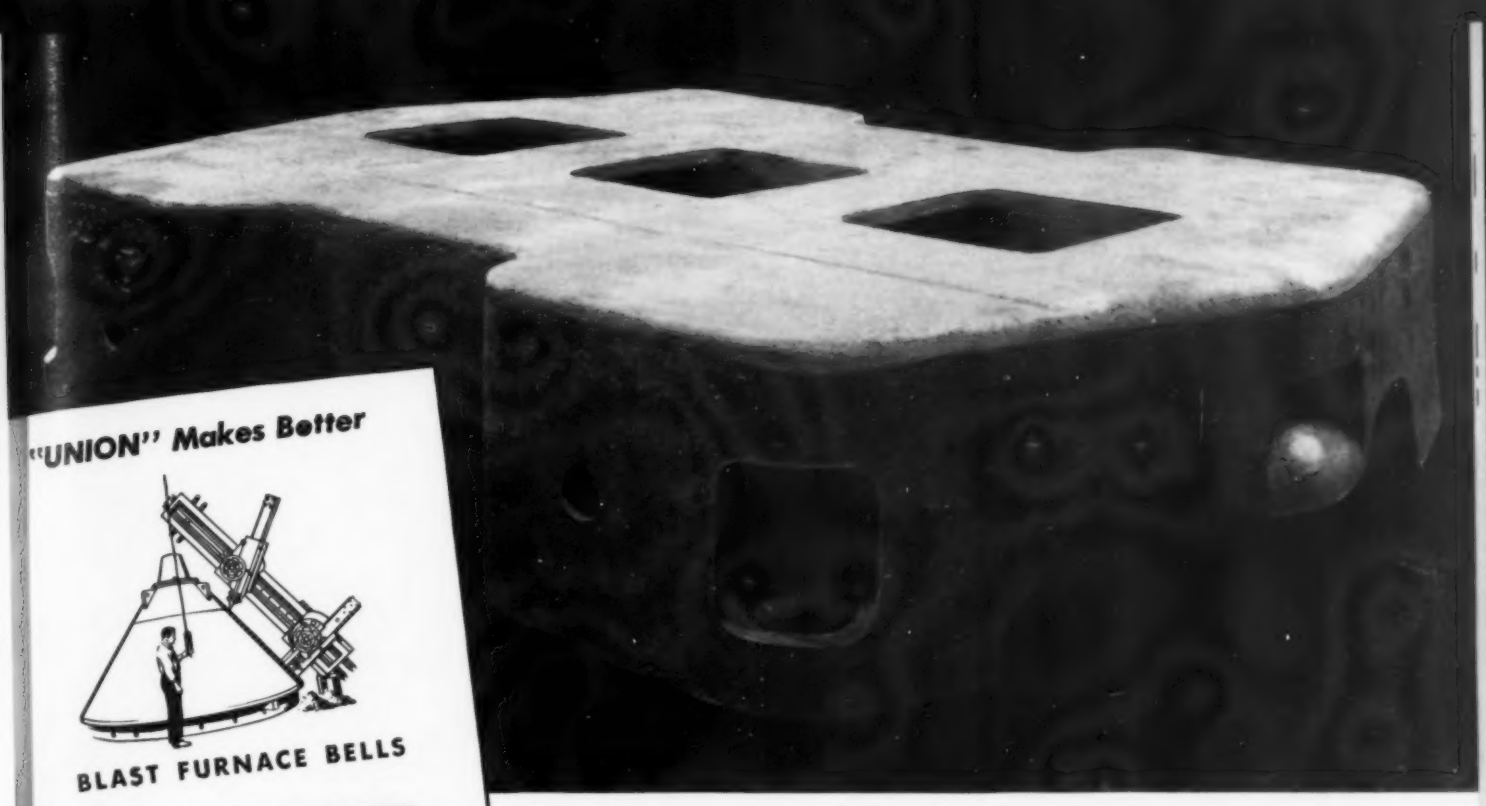
They picked the most troublesome job in the mill for us to work on. With the use of many types of high grade lubricants which would not adhere properly to the bronze slippers used in universal joint drives for the rolling mills, rapid wear, frequent renewals and general high maintenance costs were prevalent. Leadolene KLINGFAST was applied for a test. The result—*an increase* in service of 400%! KLINGFAST also prevented wear and distortion of the steel spindles and couplings at the same time—and *this* steel plant now uses Leadolene KLINGFAST on all bronze slippers and open gears.

If "you're from Missouri", let our engineers show you how easily the most difficult problem can be solved.

The Brooks Oil Co. *Since 1876*

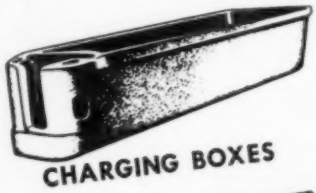
Pittsburgh 12, Pennsylvania
Cleveland, Ohio
Hamilton, Ontario

Warehouses: In Principal Industrial Cities



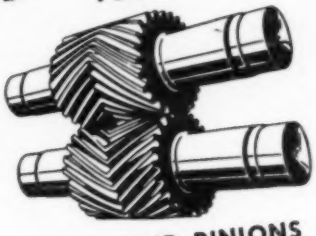
"UNION" Makes Better

BLAST FURNACE BELLS



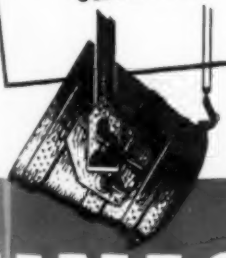
CHARGING BOXES

PEELS



GEARS AND PINIONS

SLAG AND CINDER POTS



Just what the customer ordered—*PLUS*

"Union" Ingot and Charging Cars are available in several approved designs, but the majority are built to customer's specifications—*plus* basic improvements exclusively "Union's." These insure a balanced distribution of the load, strength where strength is needed, less tractive effort required for capacity loads.

Your request for further details and estimates will receive our immediate attention.

UNION STEEL CASTINGS

DIVISION OF BLAW-KNOX COMPANY . . . PITTSBURGH 22, PA.

Recirculating Radiant Tube

ANNEALING FURNACES

One of many fine-performance features: the unique Swindell-Dressler *high velocity* burner, which gives better, more uniform distribution of heat in the tube . . . and very exceptional tube life with coke oven gases (2 to 3 times normal). *May we consult on your needs?*

SWINDELL-DRESSLER *Corporation*

Designers and Builders of Modern Industrial Furnaces

PITTSBURGH 30, PENNA.

Having ROOF trouble?

Use TASIL to prolong roof life of direct arc furnaces

• When operating conditions are just too rugged for ordinary refractories, Taylor Sillimanite (TASIL) is being installed and increasing roof life on Direct Arc Furnaces at lower refractory cost per ton. TASIL can do the same for you.

Roofs formed of TASIL ramming mix, bricks and special shapes are in service today on furnaces ranging in size from 50 pounds to giant 50 ton units, melting a great variety of steels and alloys. TASIL specified for:

High Softening Point
P. C. E. of Cone 38 (3335° F.) or 200 to 300° F. above those of the best grades of silica, super-duty silica, fire clay and super-duty fire brick.

High Hot Strength
No gradual softening below the critical point.

High Spalling Resistance
No loss in Standard ASTM Panel Spalling Test.

Chemical Stability
Attacked by high iron slags, but more slowly than fire clay base, silica or other high alumina refractories.

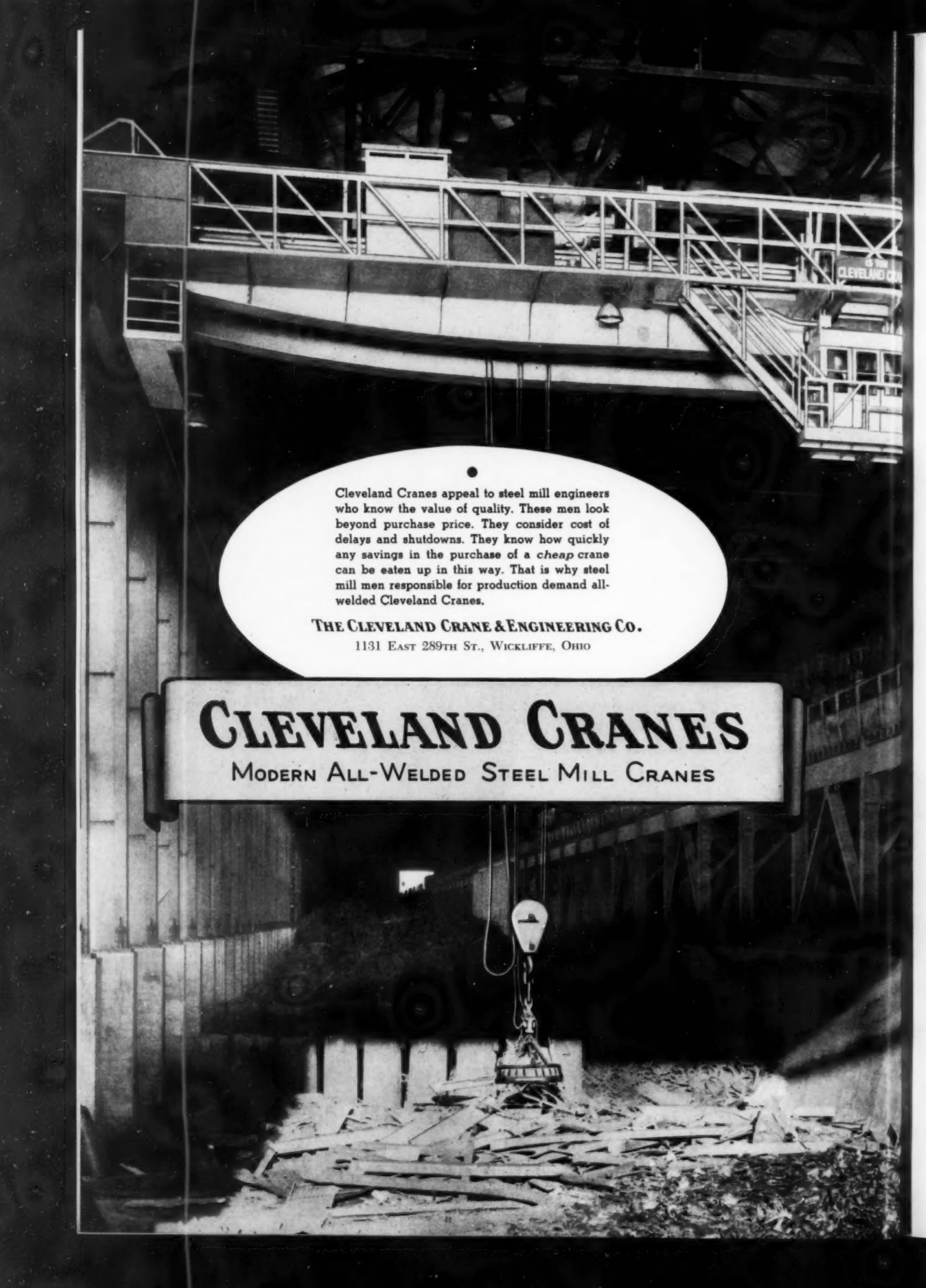
The initial cost of TASIL is slightly higher, but when that all-important denominator—REFRACTORY COST PER TON OR PER HEAT—is calculated, TASIL costs LESS.

Contact the Taylor representative in your area or write us direct to get the facts on the savings possible in YOUR plant.

Refractorers to industry since 1864.

Exclusive Agents in Canada:
REFRACTORIES ENGINEERING AND SUPPLIES, LTD.
Hamilton and Montreal

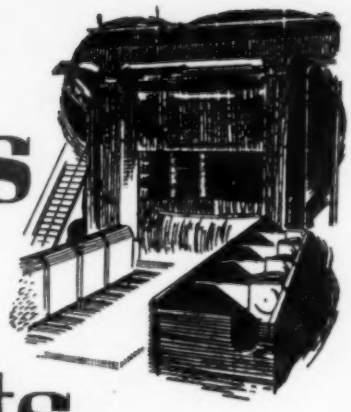
The CHAS. TAYLOR SONS Co.
REG. U. S. PAT. OFF.
MANUFACTURERS OF REFRACTORIES • CINCINNATI • OHIO • U. S. A.



Cleveland Cranes appeal to steel mill engineers who know the value of quality. These men look beyond purchase price. They consider cost of delays and shutdowns. They know how quickly any savings in the purchase of a *cheap* crane can be eaten up in this way. That is why steel mill men responsible for production demand all-welded Cleveland Cranes.

THE CLEVELAND CRANE & ENGINEERING CO.
1131 EAST 289TH ST., WICKLIFFE, OHIO

Crops *and* Shorts



REPRESENTATIVE Emanuel Celler is beginning an investigation of "concentrations of economic power" — in other words, bigness. His investigation will start with United States Steel Corp., that industrial giant that has become a prime target for politicians-on-the-make. Total U. S. Steel income is currently about $2,500,000,000 per year, approximately 2½ times what it was in the better prewar years. On the other hand, the current federal government budget is about $45,000,000,000, or 11 times what it was in prewar years.

President Truman wants government to have the power to control the size of any business if its size tends to reduce competition. Who's going to control the size of government?

▲

AND again, the Joint Congressional Economic Committee has prepared a report that puts the steel industry virtually in the class of a public utility whose prices should be watched closely (or even regulated) by government. This stirs up some interesting comparisons. Since prewar years, the average steel price has gone up some 72 per cent, or about $34 per ton. Based on the present consumption rate of 1000 lb of steel per capita per year, this increase has cost each of the general public $17 per year.

During the same period, food prices have gone up approximately 123 per cent. This increase, reflected upon a typical food budget, has cost us approximately $165 per year per person. Yet the same government that thinks steel prices should be regulated is spending the tax money we pay ($4,000,000,000 to date) to prop up food prices.

What prices need regulation?

▲

ALL in all, we heartily agree with the individual who said government is like a stomach. If it's doing its work right, you hardly realize you've got one.

▲

ACCORDING to Dr. R. E. Zimmerman, vice president of research and technology, United States Steel Corp., the steel industry must spend between three and four billion dollars in the next few years to develop essential raw material sources and to keep its producing facilities competitive and efficient. Since risk capital is very scarce and borrowing must necessarily be restricted, much of the money must come out of company earnings.

IN the wake of a job survey wherein an office staff was asked to list their various duties, one of the girls passed in something about as follows:

I watch the board. I buzz the buzzards
Who want the mail I carry back.
The girl who's anxious for the plates
Will have to wait till I eat my snack.

I take dictation every day
With never any time for play.

I greet the jerks who barge on in
When what they need is a clip on the chin.

When I hear, "Any mail today?"
You know just what I'd like to say.

And when it nears the time to go,
I think that everyone should know
I watch the clock just like a hawk,
And if anyone lets out a squawk
I'll flip my hip and out I'll walk.

And if I hear just one more bell
The whole damn office can go to hell!

▲

ALTHOUGH every March 15th increases our gratitude toward the prepayment of income tax, the fact becomes more evident each year that the great majority of taxpayers have come to regard what is left after the withholding tax as their income, and to forget the money deducted. If everyone had to pay his income tax in one lump, the howls would be longer and louder, and perhaps more effective in bringing about government economy and budget reduction.

During 17 of the last 19 years our Federal government has operated its affairs with deficits. The fiscal year of 1950 will see a further deficit of perhaps $5,000,000,000. How many of us as individuals, or how many of the industrial corporations that politicians delight in castigating, could survive such a financial history?

▲

SUBSIDIES, doles, handouts — they're wonderful! — or are they? Thousands of individuals who should take care of themselves are living wholly or in part upon the supposed bounty of the state — actually upon the taxpayers. Governmental benefits don't come from Santa Claus, but out of the pockets of each and every one of us. And the most disturbing thing is that more and more people are reaching out for the supposed free lunch. As the Wall Street Journal observed: "When everybody is subsidizing everybody else, who is going to pay for everybodies' subsidies?"

Samuel Gompers once said: "Doing for people what they can and ought to do for themselves is a dangerous experiment. In the last analysis, the welfare of the workers depends upon their own initiative. Whatever is done under the guide of philanthropy or social morality which in any way lessens initiative is the greatest crime that can be committed against the toilers."

And recently, Dr. Vannevar Bush stated: "If we go all the way down the path to dependence and render ourselves a people fawning for handouts on an intriguing bureaucracy, Russia can cease its building of war machines. It will conquer the world without them."

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Less manpower needed.

Greater flexibility — several different widths can be pickled at the same time.

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No hairpinning required — another big time-saver!

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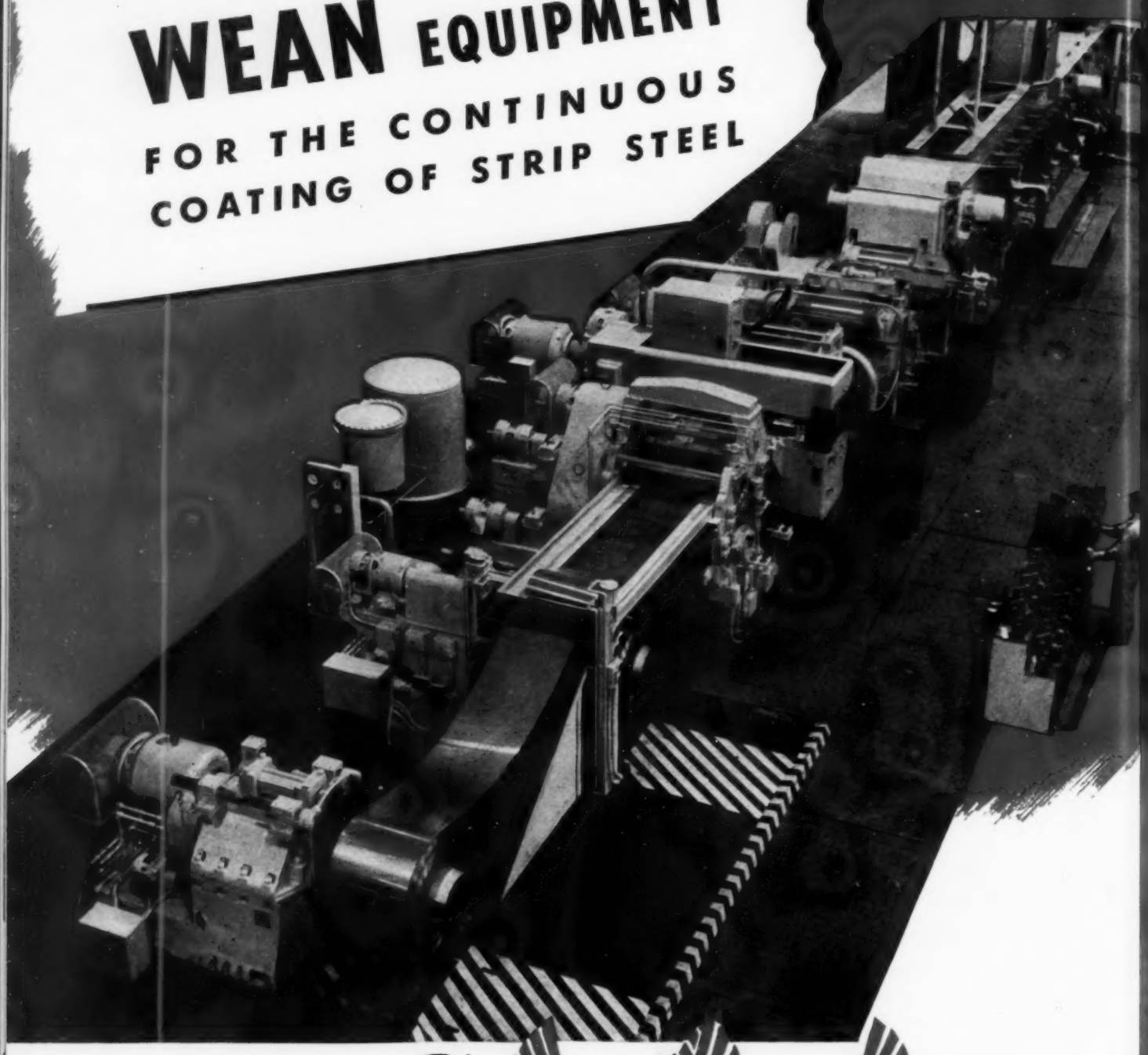

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Iron and Steel ENGINEER

MARCH, 1950 VOLUME XXVII NUMBER III

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Published Monthly by
ASSOCIATION OF IRON AND STEEL ENGINEERS
1010 EMPIRE BUILDING
PITTSBURGH 22, PENNSYLVANIA

Statements and opinions given on articles and papers appearing in "Iron and Steel Engineer" are the expression of contributors, for which the Association of Iron and Steel Engineers assumes no responsibility.

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Indexed by Engineering Index and by Industrial Arts Index.

Single Copy Foreign Prepaid $2.00 Single Copy $1.50
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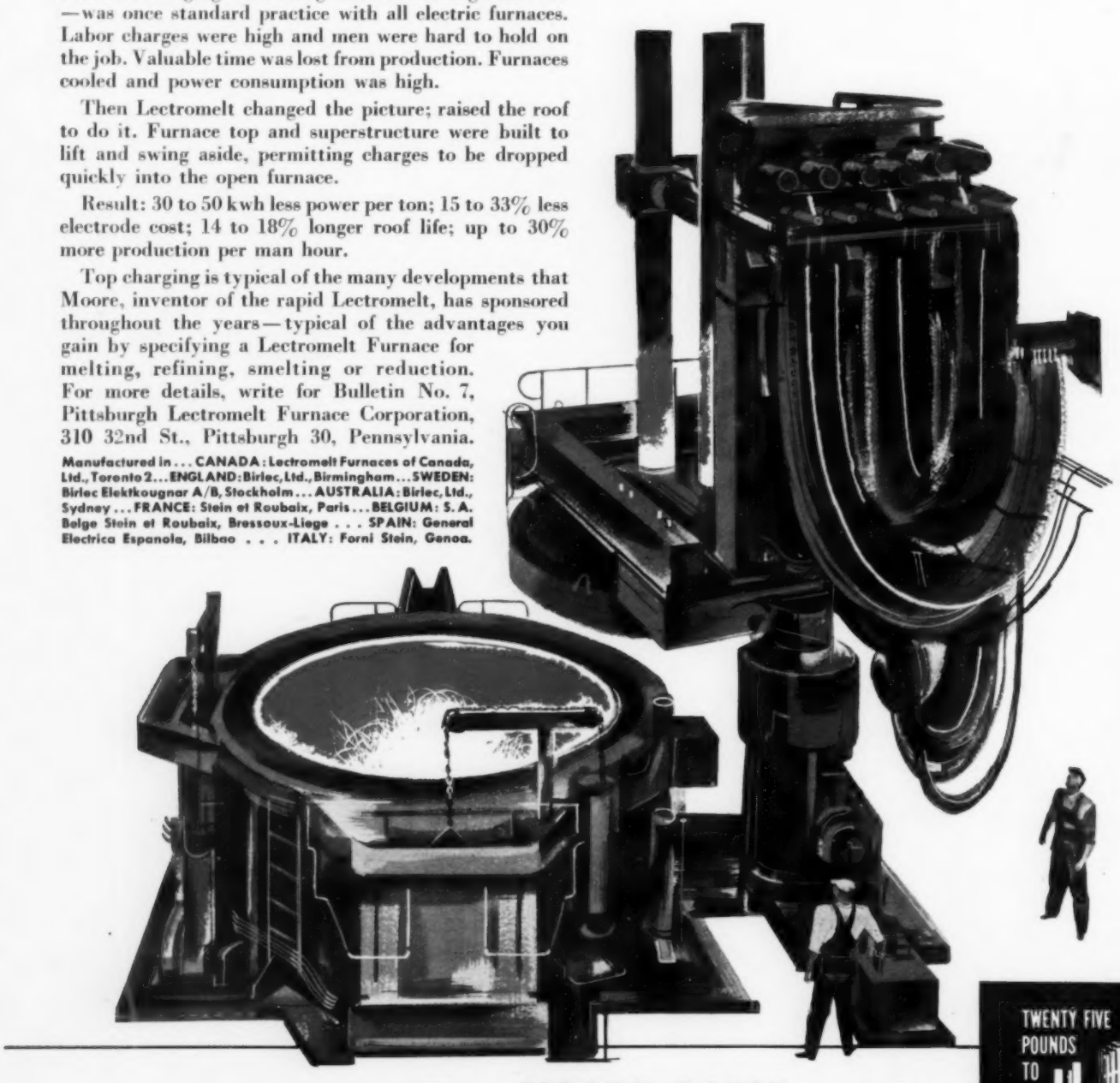


WHEN YOU MELT... MOORE RAPID *Lectromelt*

Network Calculator and its Use

IN THE STEEL PLANT

. . . . studies with the network calculator can often effect considerable economies in power transmission system design . . . .

By S. EIN
Electrical Engineer
Armco International Corp.
Chicago, Ill.

▲ MANY steel mills have electrical systems comparable in size to that of large utility companies, but with the added feature of having the electrical system concentrated in a much smaller area. These utility companies have used network calculators for many years to determine the best answers to their problems. To serve these companies the number of these calculators has grown in the United States from four in use 16 years ago to 21 at present, either in existence or being installed.

Like utilities, steel companies have also turned to network calculators for answers to problems arising on their electric systems in order to secure the best economy and continuity of service. Engineers of one steel manufacturer have used such network calculators either in the east or locally since 1935 with good results. This discussion is based on this experience.

The discussion is not intended as a complete guide for a network calculator study, but has as its purpose only the object of pointing out how it can be used in a steel mill and where it has been used to advantage. Except where otherwise noted, 60-cycle systems are considered. It is, of course, realized that any system may be studied, be it 25, 50 or 60-cycle.

The discussion of the network calculator will be divided into three general classifications: (1) briefly what it is, (2) what studies can be performed on it, and (3) some examples of studies carried forth on the calculator.

Since the term "network calculator" is somewhat lengthy, the word "board" will sometimes be used as a synonym for it.

As an illustration of such a board, the one at the Illinois Institute of Technology in Chicago, Ill., will be used. This board is three years old, and while slightly smaller than the largest one in the eastern part of the United States, it is fully adequate for all purposes and is as modern as any.

Oversimplifying the description a little, the network calculator is a means for operating any electrical system in miniature, in any desired combination of parts, and observing the results under either normal or abnormal operation as desired, in order to check in advance whether or not the desired results can be obtained. It sometimes happens that after a system has gone into service without a board study, it has been later found that the system could have been designed at lower cost, since it is a human tendency to pile up safeguards such as excessively large lines and transformers, alternative feeds, and high rupturing capacity breakers. The board helps evaluate the facts of the most economical design. As far as management is concerned, a board study, when made, shows that the effect of the addition of a mill or generator has been studied as part of the whole problem of the steel plant or district, and that the engineering department is on sure ground and will not backtrack.

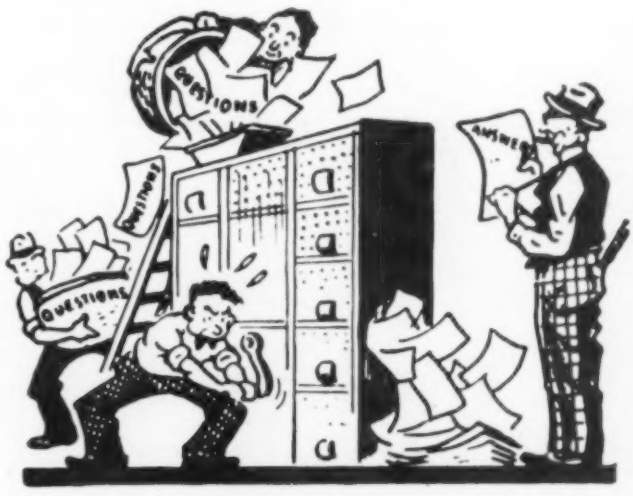
First, the board is not a device for putting in problems and data, turning a crank blindly, and getting answers, as Figure 1 would indicate. The nature of the answer sought must be known, and the people performing the studies must know what they are doing.

The board is a combination of resistances, reactances, and auto-transformers which receive power from a 440-cycle alternator, the high frequency enabling smaller parts to be used. The alternator is the only continuous rotating part of the board. These elements can be combined in any desired fashion to represent the lines, loads, generators and transformers of the actual electrical system being studied.

Figure 2 shows an overall picture of the board, the desk with the meters which read the electrical quantities found by the board, and a conference table.

Figure 3 shows a closeup of part of the board, and

Figure 1 — The network calculator is not this type of device.



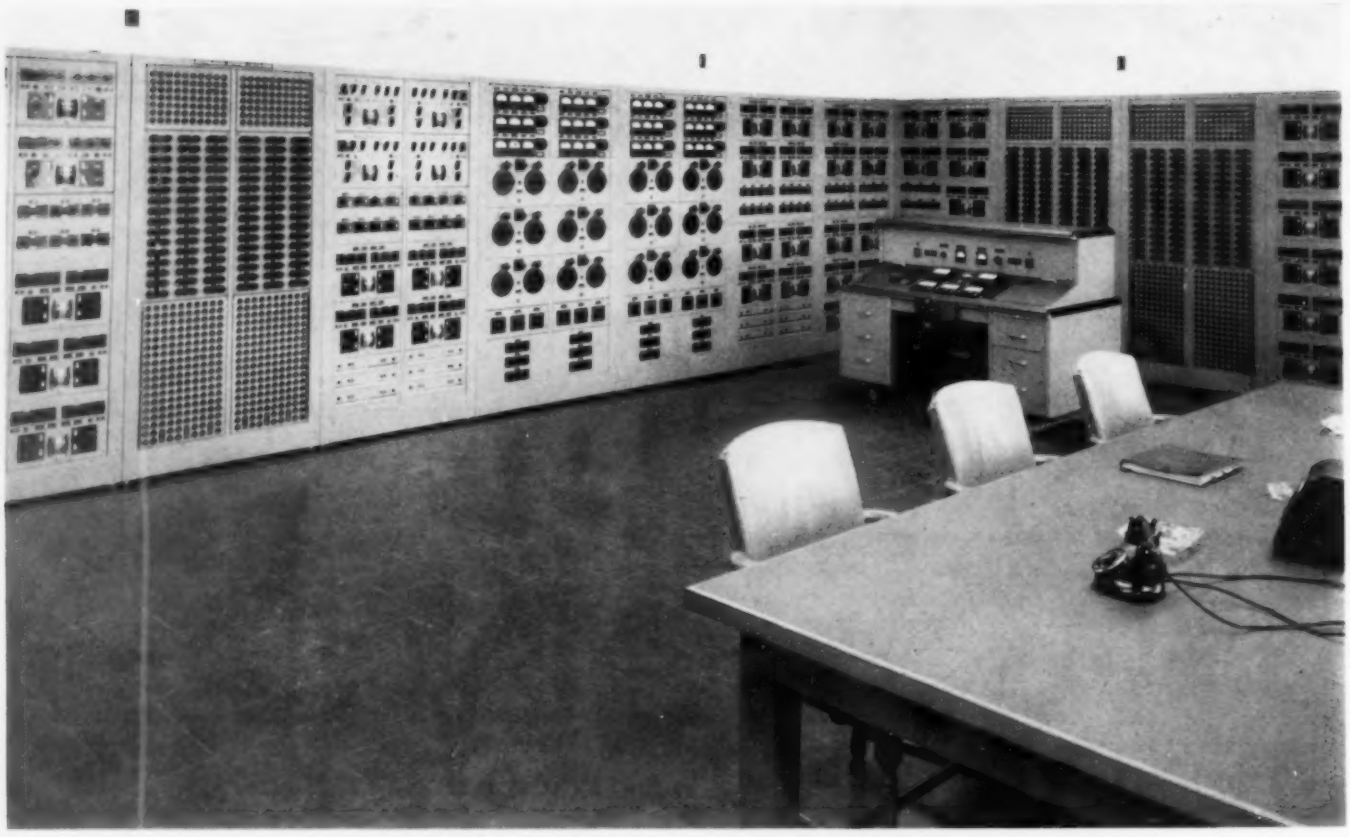


Figure 2 — General view of the network calculator.

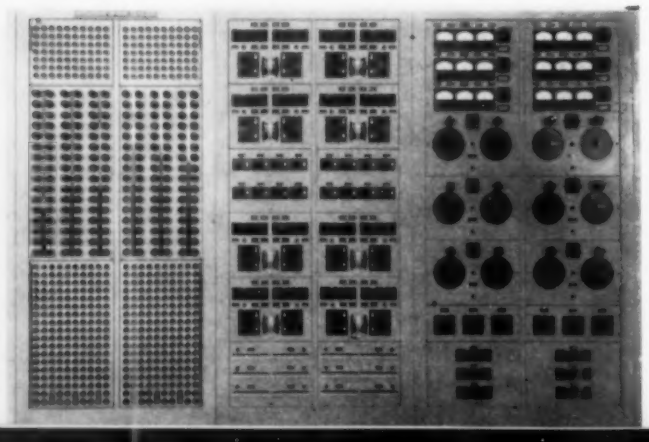
reading from right to left are generators, load units, and plug board for making connections.

Figure 4 shows the internal parts of a generator unit drawn out into view.

Figure 5 shows a study being made, a closeup of the meter desk, and the table at which data given by the board are written on a copy of the diagram being studied.

The types of studies which the board can handle are three: (1) short circuit study to show amount of current circulating during fault, in order to determine short time and interrupting capacity ratings of breakers, and for use in setting protective relays; (2) checking voltage regulation and powerflow and size of lines and transformers, all during normal operation; and (3) stability, or checking whether or not generators and motors will remain in step after the occurrence of a violent system disturbance such as application of fault, or removal of line or piece of equipment. This also includes stability after reclosing of the previous faulted circuit subsequent to removing the fault.

Figure 3 — Closeup view of part of the board. Plugboard for making connections is at left.



Before performing the studies, the data of the system must be available when the engineers arrive at the board. The gathering of the data is not difficult. If the system is only in the planning stage, there is first needed a simplified diagram of its component parts in their approximate geographical relationship. The data on impedences of machinery, transformers, and lines, and on inertia constants can be secured from publications of the larger electrical manufacturers. While such data is approximate, it is remarkably accurate because from long experience the manufacturers can give the best values to use. Because of the large number of items of equipment considered on the study, plus and minus errors nearly average out, leaving the results reasonably accurate.

If the system is an existing one, the required data can be secured from available records. Since such data can approach 100 per cent accuracy, the board's results will have errors of only one to three per cent.

With the gathering of the data there should be written a short memorandum, giving the salient features of each system studied, and the objectives of the study, such as rupturing capacity of breakers planned, voltages sought, whether or not it is stable, etc. This memorandum should then be approved by management, and by representatives of both the engineering and operating departments. Such a maneuver should help facilitate procedure of the study.

Finally, but not least, there must be present at the board at least one representative from each system being studied who can approve results secured on the board, make changes, or secure additional data when

needed. Too much stress cannot be placed upon having this man present, since past experience has shown that tests have faltered and time has been wasted when such man is not present.

Then, with one man appointed to prepare a report from a log of the tests made by him, all preparations for the studies are complete.

Figure 6 shows the end result of the first of the three studies described as being performed on the board; i.e., fault currents on short circuit. As the figure demonstrates, the data found by means of the board is set down on the previously described system diagram. The one shown is that of a large plant whose features are as follows: The hot strip and cold rolling mills are fully developed for the present, and each have average hour demands of 40,000 kw at 95 per cent lagging and unity power factors, respectively. At the left steel plant, one 60,000-kw generator is installed and the only load there is an electric furnace plant which does not contribute fault current. At the right steel plant, one 60,000-kw generator is installed to feed blast furnaces, rolling mills, coke works, etc. The surplus power of the two generators and all of the power of 33,000-kw of 25 to 60-cycle frequency changers supply the hot strip and cold mills in the middle. The main transmission circuits are 69 kv which supply nearly all loads at 6.9 kv through transformers.

Three phase faults were applied at each 69 and 6.9 kv bus, of which one is shown by X, and the total current into each fault read as was the contribution of each source to that total.

The fault currents shown can be used in two ways. One is for checking the required ratings of breakers. For example, fault 10 shows that the highest value of 69 kv fault current found is 7600 amp. This is 912,000 kva at 69 kv and is under the 1,500,000-kva breakers proposed for this voltage. It might be pointed out that 1,000,000-kva breakers will be satisfactory on the basis of fault current shown. Other studies on the ultimate arrangement showed that 1,500,000 kva is the minimum value allowed.

The highest fault current on the 6.9 kv bus is 44,000 amp at fault 12. This is 528,000 kva, a trifle higher than that of the 500,000-kva breaker proposed for this voltage but not excessively so. The required short time rating is 1.6 x 44,000 or 70,400 amp which is a shade over the equivalent rating of the desired breaker size, according to latest standards, and is satisfactory.

Figure 4 — An internal view of the generator unit. The outside of this unit can be seen on the right side of Figure 3.

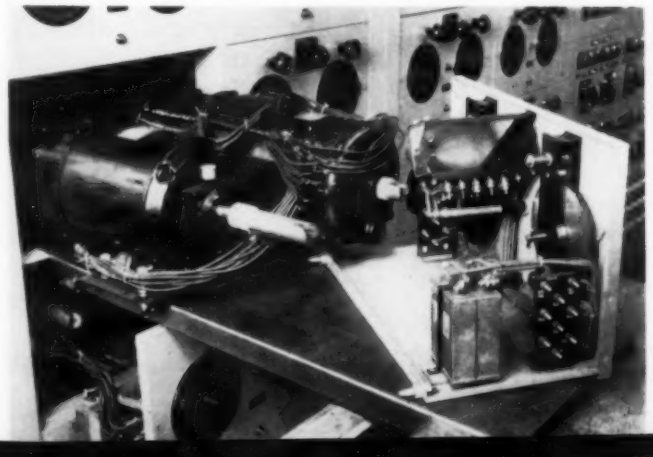


Figure 5 — A study is in progress with readings being taken and recorded.

The other use for the short circuit study is setting of relays. The flow of fault current from all sources to the point of fault can be seen by inspection of Figure 6. Those for fault 10 have been accentuated. With this data at hand, the settings of relays in the path of the fault current flow can be checked to make sure the desired relays operate and the remainder do not.

The foregoing study was made under maximum conditions; i.e., with all generators and motors on the line. Minimum conditions, that is at light operating rate, were also studied to make sure that the relays set for maximum fault will have enough fault current available on minimum conditions to operate, but a picture of the results is not shown for brevity and because the resulting picture is similar. Line to ground faults were also studied and are not shown for similar reasons.

Coincidental with the question of fault currents and relay settings, several actual cases can be cited. For example, a study was recently completed on a new 60-cycle system of blast furnace skip hoists, pumps, and auxiliaries, which was investigated with first the power coming from frequency changers and next from a public utility. A study similar to the one described was calculated and then checked on a board. The results were applied and satisfactory operation has been secured.

Another case can be cited of a short circuit study of a 25-cycle system which was expanded some years ago. Before expansion, the principal 2300-v power station was one housing a multiplicity of low reactance gas engine driven generators and lines feeding out to rolling mills, of which the two closest consisted of synchronous motors. Detailed consideration showed that the main bus was structurally too weak to withstand fault currents. A number of short circuit studies were made and resulted in a determination of fault currents and the necessity of sectionalizing the bus. With the fault currents known, calculations were made of the forces imposed on the bus during fault, and braces and insulators were installed to resist them as best as possible. The worth of the design was proved about five years ago when due to an operating error the two bus sections were tied together out of phase, causing a three

phase flashover. The bus rode through without trouble.

On one bus section of the same power station, one of the loads is an electric arc furnace plant. After the bus was split, the then electrical operating superintendent came to the conclusion that the voltage regulation was poor on that section and insisted on keeping the sectionalizing circuit breaker closed, thus nullifying the work done despite proof offered in the short circuit study. As time went on another operating superintendent arrived. He was offered the same proof but insisted on seeing the results of a study actually made before he would make a change in the operating practice. This was done on an a-c board in the east. Upon his return home the sectionalizing circuit breaker was opened and the split bus has been operating that way ever since with satisfactory voltage.

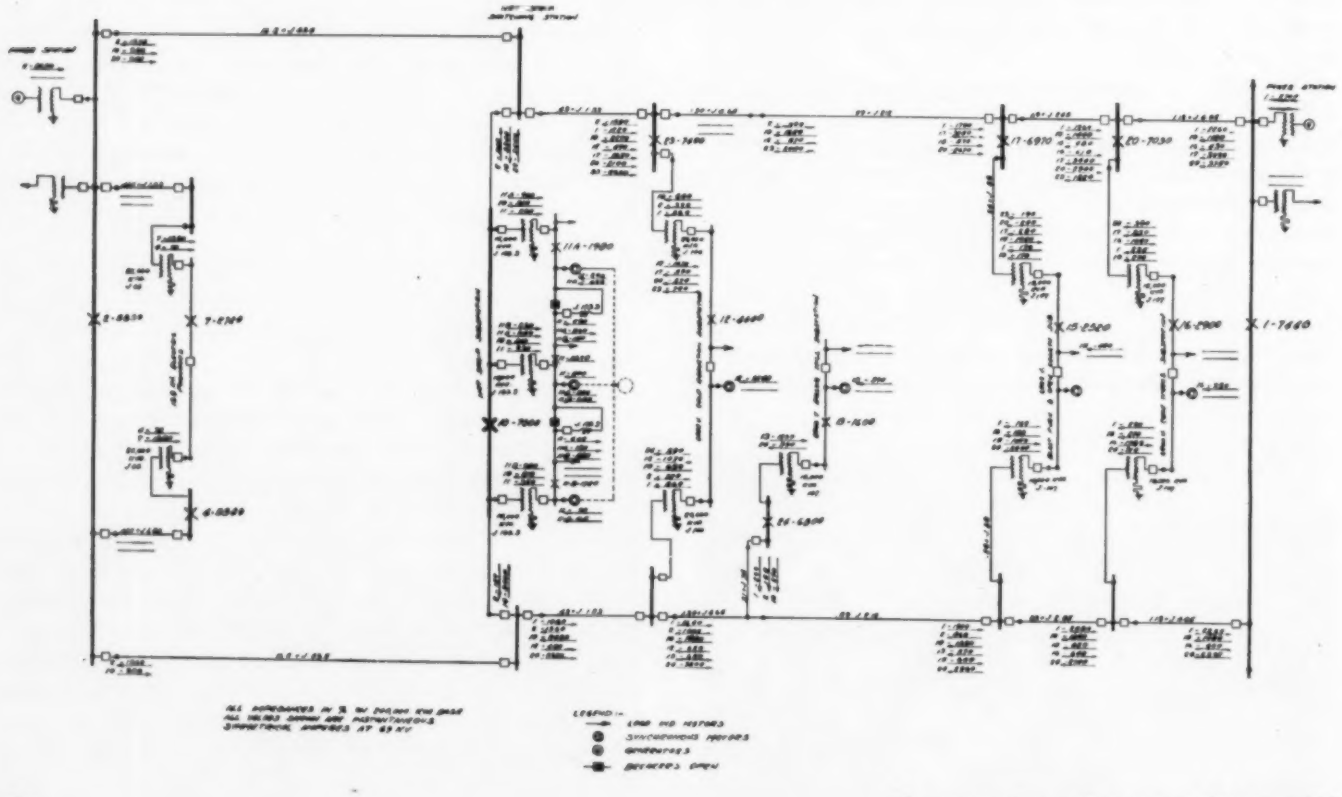
In another case in a sheet and tin mill, the operating man also insisted on keeping the sectionalizing circuit breakers closed, this time on a three-part bus. Here the engineers claimed that the short circuit duty was over even the ultimate capacity of the circuit breakers, let alone the rated capacity. Tests on a-c board showed the surprising result that the short circuit capacity was just under the ultimate capacity, and consequently nothing further has been said.

In still another instance, of two neighboring 25-cycle cinder pit pump motors, one is controlled by an adequate circuit breaker installed because a board study showed it was required, and the other one by a starter consisting of an oil-immersed double-throw switch whose inadequate rupturing capacity was ignored. The breaker has removed its motor in good shape when failure occurred, while the switch has blown up three times on fault, the last time gutting the room.

Another type of short circuit study has been made on the a-c board. This is the determination of the fault currents on the d-c bus of a hot strip mill. In one of the steel plants a hot strip mill was built as a 28-in. mill in 1928, and converted in 1935 to a 38-in. mill. It has 39,000-hp of generators, and roughing, finishing and edger motors connected to a continuous bus common to all rotating equipment and whose polarities are close together. Due to faults caused by flashovers, loss of a motor field, etc., the bus and machine windings have been severely damaged a total of four times, of which three were in the last four years. An analysis, separate from the board, was made to find a method for preventing such outages. The analysis showed that the total fault current was too high to be handled by any breaker which could be purchased. If the current could be prevented from rising to the high value, breakers could be found to handle the comparatively smaller currents. For the first time in board work, the board was called upon to find at what rate the d-c fault current rose, and this could be done because since the varying current on rise acted like an alternating current during the first quarter cycle, a step-by-step method could be used.* The study was made, and it was found that the ultimate fault current rose to 936,000 amp in five cycles at the initial rate of about 12,000,000 amp per sec. Since the existing breakers had an interrupting rating of 80,000 amp at five cycles, it was obvious that the only solution was to secure breakers of higher interrupting capacity and speed, and to split up the bus so

*This method is fully described by its originator in "D-C High Power Distribution Systems—Short-Circuit Analysis" presented at the Midwest Power Conference, Chicago, Ill., April 8, 1948 by William Deans.

Figure 6 — The drawing gives an example of record of fault current flow on short circuit.



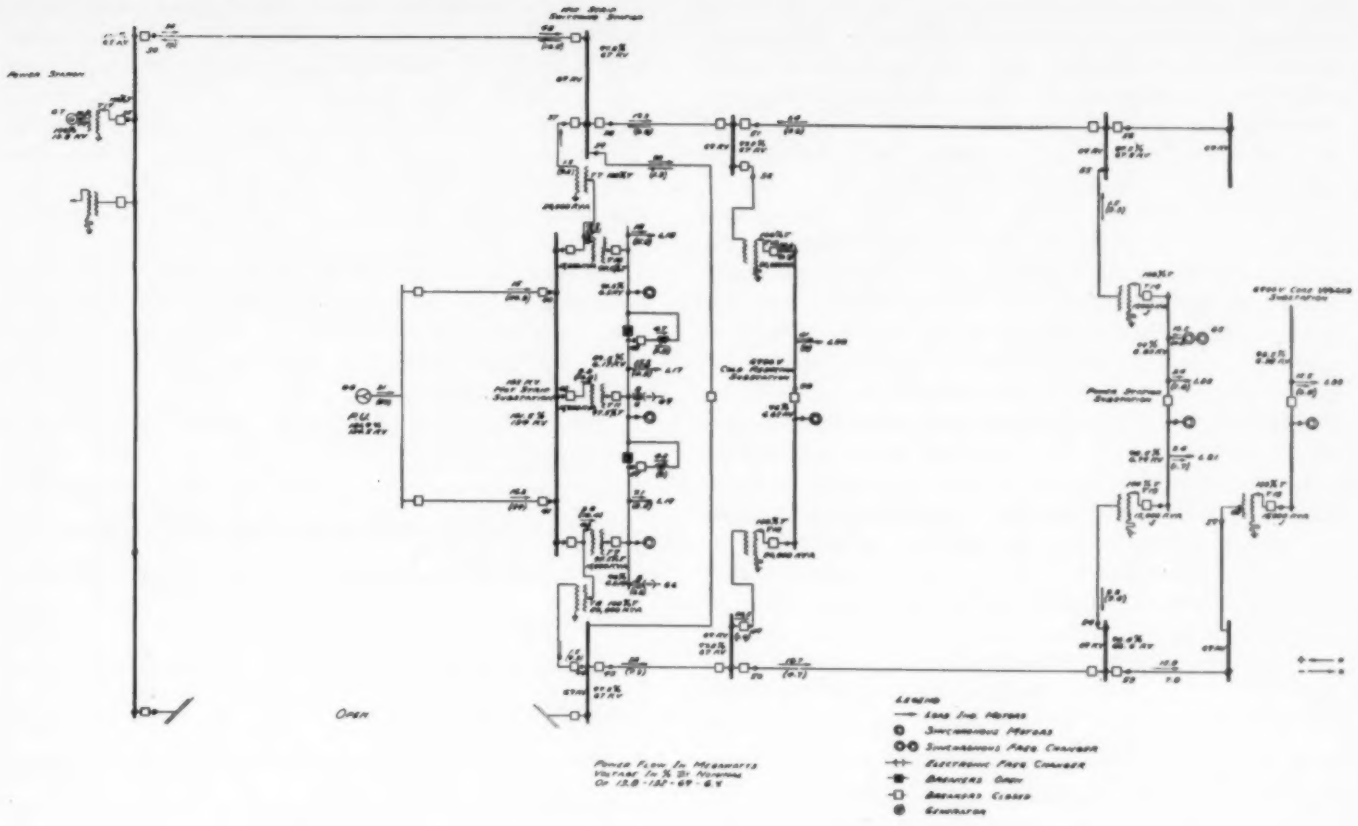


Figure 7 — Example of record of power and reactive flow, and voltage.

that the new breakers would not have an excessive duty. A workable scheme has been devised but due to the necessarily high cost it has not yet been put into effect.

The previously described fault current study is of use only in case of older mills when a remedy must be found to prevent damage. In case of later mills, bus damage has been minimized by sufficiently separating the buses.

A short circuit study was also made of substation mercury arc rectifiers in parallel operation, which also have a rapid rise in fault current, much faster than that of motor-generator sets. It was found that until the total installed capacity is over 3000 kw, which is infrequent, available breakers of reasonable cost will handle the job.

So much for short circuit studies.

A second study conducted on the board is a check of the adequacy of the lines, transformers, generators, etc., during normal operation while carrying normal loads, whether or not load voltages are satisfactory, and determination of the resulting power factor requirements of synchronous equipment. Because of the varying loads of the steel plant, either an average loading of the mills must be estimated or the peaks distributed in the same fashion they occur and the various combinations studied. After the board has been arranged to show actual conditions, voltages can be checked, transformer taps changed as required, or lines taken out of service and replaced, all to arrive at the best operating situation, and the board will give the effect.

An example of such a study is shown in Figure 7, the system of which is quite similar to that of Figure 6. In the case shown in Figure 7 a public utility has been substituted for the right steel mill's generator.

In the study of Figure 7, it was found that on all nominal 6.6 and 6.9-kv buses, the voltages were low but, except in one case, within range of the transformer taps. In this instance, for the coke works sub at the far right, other means must be found. Here, as the result of the study the engineering department representative was able to secure justification for changing the specification for a 2500-hp motor from induction to synchronous in order to secure better power factor and thus improve voltage.

As can be seen by tracing back through the accentuated figures, all equipment in the path of power is adequate; for example, there are 20,500 and 20,800 kw flowing through 20,000-kva banks. The power factor of the public service company is 55 per cent, below the point when power factor penalty clauses might be invoked. Since the generator's power factor is unity, there is room for this unit to carry part of the wattless and raise the utility's power factor. Later studies, not shown, proved that the situation could be remedied as described.

In a study of the right steel plant's ultimate system, checks were made of the effect of deferring construction of certain lines (not shown) which parallel the lines numbered 38-51-56-45-50-53 on the figure. The results showed that even with the worse practicable condition of failure of the lines whose numbers were just listed, the lines remaining in service would carry the loads

without any trouble. As a result it is now planned to let the decision whether or not to install these certain lines go until the last or nearly the last generator of the ultimate number of four is installed. Since the first generator will not be installed for at least two years from now, it can be seen that time will make the savings in carrying charges amount to a satisfying sum.

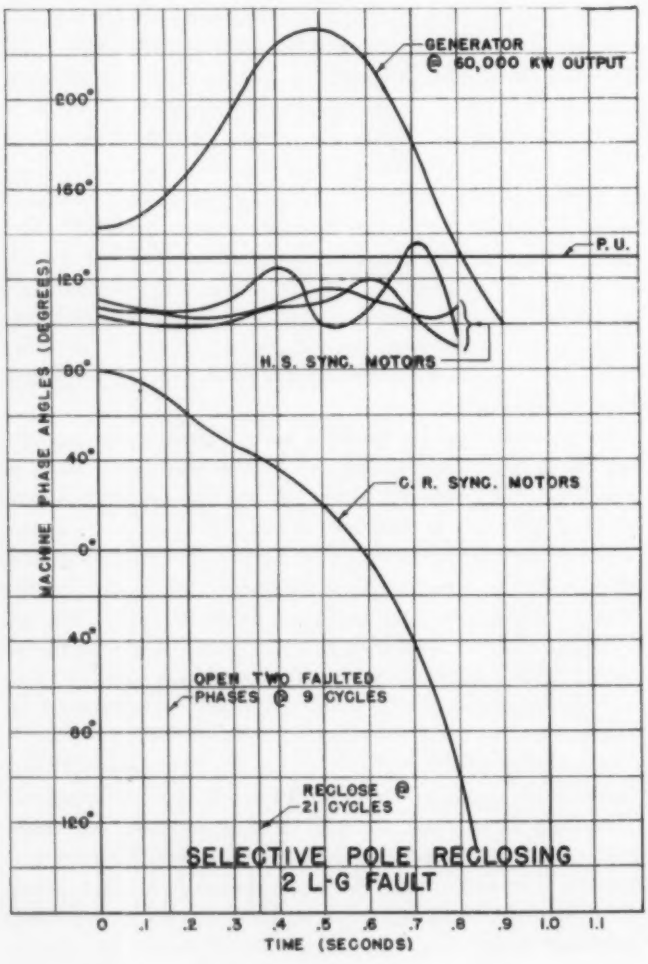
The third and last study conducted is that of stability. Instability occurs because during a fault the generators rapidly change their load and speed, since the governors are much too slow. Synchronous motors behave as generators because of the stored energy of themselves and the driven load. As soon as the fault is removed, generators tend to recover their normal load. This surging of power between generators and motors set up oscillations. If the internal damping forces of machines are sufficient, the equipment can settle down into equilibrium and continue to operate after the fault is removed. However, sometimes the acceleration or deceleration of a piece of synchronous equipment cannot be reduced and it falls out of step, that it is unstable for this condition.

Up to this time there has not been found a case in a steel mill itself—that is, among its own generators and synchronous motors where a public service company has not entered—in which a study has shown instability. This occurs because lines are short and reactances between generators and motors are low. However, this must not be accepted as a rule because each plant should be checked thoroughly to make sure that some condition, such as high reactance resulting from more than one transformer bank in a series plus that of the line and reactors, does not create a condition leading to instability.

In cases where several plants are interconnected, or where a public utility is involved, or both, stability can be a problem because lines are longer and more than one transformer can occur in series. Such a case will now be described.

Figures 8, 9 and 10 show the results of a stability problem. Before these are discussed the situation which

Figure 8 — Example of stability record with use of selective pole reclosing on two line to ground fault. H.S. Sync. motors = hot strip mill synchronous motors. C.R. Sync. motors = cold mill synchronous motors. P.U. = Public utility. Cold mill synchronous motors show an unstable condition.



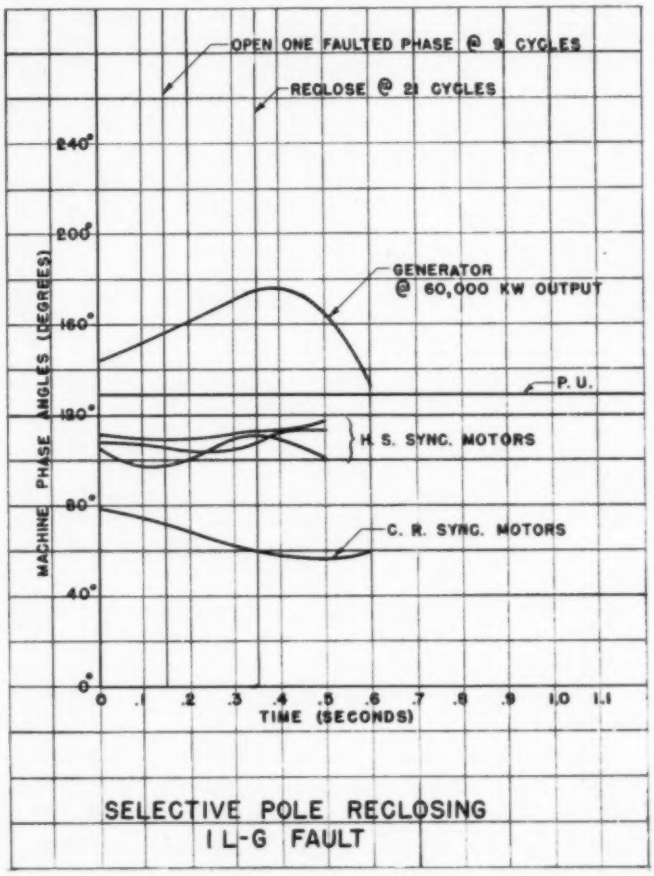


Figure 9 — Example of stability record with use of selective pole reclosing on one line to ground fault.

required study will be described from Figure 7. As explained before, a generator at the left steel mill and the public service company feed a hot strip and cold rolling mill, and the beginnings of a 60-cycle system for the right steel mill. Two lines are now in existence from the generator to the hot strip mill substation as interconnections between the 25-cycle systems of the left steel mill and the steel mill on the right. To secure a line for the generator, it is proposed to convert one of the two lines to 60-cycle use, leaving the other line to interconnect the 25-cycle systems as before. The stability study was made to make sure the one 60-cycle line shown was sufficient.

Types of fault will be discussed for a moment. Good authority* gives the following figures to indicate the

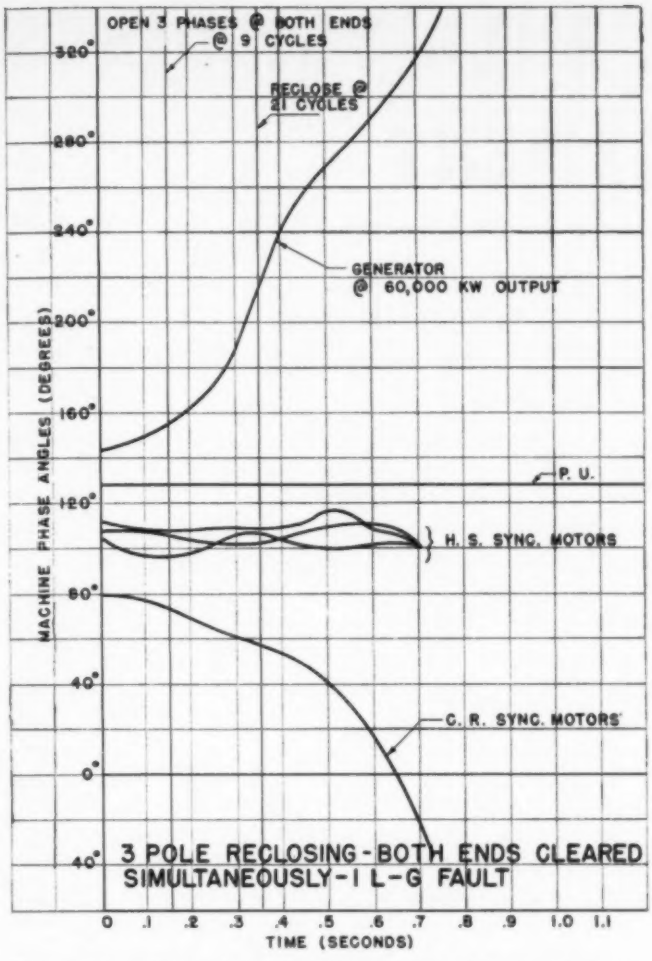


Figure 10 — Example of stability record with use of three-pole reclosing on one line to ground fault. Generator and cold mill synchronous motors indicate unstable condition.

order of prevalence of all faults occurring on a transmission line like this one, which is installed on open ground and subject to lightning and other hazards: 70 per cent are one line to ground faults, for example flashover of an insulator string; 10 per cent are two line to ground faults; and the remainder, line to line or three-phase faults. Of these faults, two line to ground faults are an accepted criterion for use in designing for stability.

The use of three-pole circuit breakers and the possibility of reclosing to maintain service after the breaker has opened to remove a momentary fault is a well-known fact, but is rarely used in steel mills. Some public utility companies have found that on single line interconnections, three-pole reclosing does not give satisfactory stability, and they have gone to selective pole reclosing. In this type, each of the poles of a three-pole breaker is separately controlled and relayed. Upon occurrence of faults, only those poles of the breakers at each end of the faulted wire or wires open, leaving the other wires to remain intact to transmit synchronizing power between the systems at the ends of the line.

With the foregoing facts on types of faults and selective pole reclosing in mind, Figures 8, 9 and 10 will now be discussed. Referring to Figure 8, there is seen the result of a stability test made with 60,000 kw carried by the line. It was assumed that the fault was two line to ground and that five-cycle selective pole breakers were installed at each end with carrier current relaying. The fault was applied at the terminal of the left generator's transformer at zero on the figure, kept on for nine cycles, the circuit breakers opened for twelve more cycles, and then reclosed. As can be seen, the three groups of motors at the hot strip mill were stable. While the generator recovered, the cold mill's motors were unstable as shown by the continuing divergence of their curve. Therefore, this condition is unsatisfactory.

Since the most severe type of fault which is a criterion for line design (two line to ground) did not produce satisfactory stability, the less severe but more common type of fault, one line to ground, was used in the next study with all other conditions of the previous test kept intact, including 60,000 kw in the line. In this test, as can be seen in Figure 9, satisfactory stability resulted on all items of equipment as shown by the fact that the curves for the generator and cold rolling synchronous motors move back together after reclosing occurred.

However, because a two line to ground fault is still the criterion, a stability study was made with this fault when the line carried 50,000 kw. The reduced load permitted stability and curves similar to those of Figure 9 were secured but are not illustrated here. As the result, the line was given a rating of 50,000 kw as to stability.

To avoid criticism that the standard three-pole gang operated breaker would give stability without the slight complications of selective pole reclosing, a test was made with this type of breaker and the most favorable type of fault, one line to ground. As Figure 10 shows, completely unsatisfactory results were secured as shown by the fact that the curves for both the generator and the cold mill motors both keep on diverging after reclosure. This proves that the use of selective pole reclosing breakers gives the only answer to this particular problem: one line between the two steel plants.

After all the tests have been made, a report must be compiled to justify the making of the test. It may be made as lengthy as desired, but a summary of the results secured should be short, about one page, placed at the beginning of the report where it can be easily found by management for future guidance.

The cost of such a study as has been described is surprisingly small. For the approximately equal items of the out-of-pocket expense of the board and of the time of the engineers involved, the total is about the cost of one-half the cost of a circuit breaker, or the installed cost of about 500 ft of underground three-conductor cable, or conceivably the cost of a shutdown in lost time. Thus, the savings of a board study is over and above whatever has been saved of the items just described.

Summing up the foregoing, a steel plant can make very good use of a network calculator and secure very satisfactory monetary return. In addition, the engineers are on firm ground and give management the correct impression that the problem in hand has been thoroughly studied.

*"Electrical Transmission and Distribution Reference Book" by Central Station Engineers of Westinghouse Electric Corp., Page 237.

PAINTING OF STEEL MILL BUILDINGS AND EQUIPMENT

. . . . economical paint life requires proper surface preparation, application, film thickness, and material selection . . . .

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Homestead, Pa.

▲ THROUGHOUT the history of the industry, the nature of the operations performed in the manufacture and processing of steel has generally necessitated the use of steel for housing these operations. Furthermore, most of the equipment used in these operations is constructed of steel so that most plant paint problems are those arising from its use on steel surfaces.

Undoubtedly the most important single consideration is the continued maintenance of adequate surface protection of mill buildings and other exposed structures. It is well appreciated that the low cost constructional steels rust even when exposed to ordinary atmospheres. In steel plants, proximity to gaseous products of combustion, abnormal temperatures and a variety of other influences lead to an accelerated rate of corrosion. The degree to which such influences may affect the life of a metal coating, for example, is well illustrated by an authoritative estimate of the life of a galvanized coating of two ounces per square foot in various atmospheres. It is estimated that such a coating will last approximately 150 years in certain dry tropical locations, 25 years in rural England, 5 years in urban England and one year in an English railway tunnel.

In the application of paints, experience has shown that the following fundamental requirements must be adhered to if satisfactory performance is to be obtained:

1. The preparation of surface.
2. Application of coating under proper conditions.
3. Adequate film thickness.
4. Selection of material.

The success or failure of any paint job starts with surface preparation. To obtain a satisfactory bond between surface and paint it is necessary that the paint make intimate and complete contact with the surface. It is obvious that any foreign substance such as rust, loose scale, old loose paint, dirt, grease, oil film, moisture, acid or alkali, even though this substance may be invisible, separates the paint from the steel. The practice of painting over tightly adhering mill scale is generally considered acceptable when priming structural materials.

Because of the importance of surface preparation, the subject has been given considerable attention so that quite a number of methods have been developed. These include mechanical methods such as wiping, manual and powered wire brushing, scraping, manual and pneumatic chipping, and sand, shot or grit blasting; chemical methods such as application of volatile organic solvents, hot caustic solution or acids, and finally a thermal method using an oxy-acetylene flame. This latter method will remove rust and loose scale effectively, and has the additional advantage that it drives moisture from the surface; that is, dehydrates it. The use of compressed air, water or steam will be advantageous in certain instances. In using chemical solvents, it is essential that all traces of the solvent or residues be removed before painting. Irrespective of the method employed, its effectiveness will be in proportion to the thoroughness of the operation.

It will be appreciated that the thorough removal of corrosion products from surfaces of erected structures requires painstaking manual effort and adds considerably to the expense of repainting. Consequently, repainting should be scheduled before corroded areas become extensive; in fact, if practical, before they occur at all. It is realized, of course, that there are instances of isolated small areas where the coating becomes accidentally damaged but which do not reflect its condition as a whole.

The importance of regular inspection is to be stressed. Too often, repainting is delayed so that either permanent damage results or the expense of reprotecting is disproportionately high compared to any temporary savings effected by such postponement.

In addition to its being a foreign substance, water is a universal ingredient contributing to rust formation, so that it is imperative that surfaces be free of water in any of its various forms when being painted. For this reason, painting specifications frequently stipulate that no exterior painting be done when the temperature is below 40 F.

A priming coat should be applied as soon as possible after the surface is prepared. Also, successive coats should be applied as soon as practicable, after drying of the preceding coat. Even though this is sound practice under ordinary conditions, it becomes increasingly important in areas where chemical contaminants are present to an appreciable degree. Notwithstanding the fact that most paints are quite resistant to the attack

of dilute acids, minute deposits of foreign chemicals between metal and paint, or between successive layers may, by the introduction of a water sensitive film cause corrosion of the underlying metal and loss of adhesion between paint and metal or even between successive coats. In extremely unfavorable locations, it is advisable to schedule maintenance painting to correspond with periods of suspended operations in the producing unit if at all practicable.

Thorough mixing of the pigment and vehicle at the time of painting is, of course, to be observed. Mechanical stirring is recommended when paint is mixed in drum lots.

If a surface is properly prepared and a quality paint applied under satisfactory conditions, the protective value of the coating will depend largely upon the thickness of the film. To a certain degree, paint films are permeable to moisture and gases and as film thickness decreases, permeability increases disproportionately in the range of thicknesses normally applied. Measurements made on the passage of moisture through films of various thickness indicate, for example, that with a given paint, a minimum film thickness of three mils is required for satisfactory performance and that a thickness of four or five mils is to be preferred.

In emphasizing the importance of adequate film thickness, it is to be realized that any individual coat may be applied too thickly so that uneven and prolonged drying produces an undesirable, wrinkled surface and delays the application of successive coats. There is less danger of this occurring when brushing than when spraying. In spraying there is also more danger of applying coats too thinly; consequently, special attention should be given each coat when applied by this method.

The practical extension of the foregoing discussion is that a minimum of three coats is usually recommended for new work, a single shop priming coat and two coats after erection; also, repainting may be conducted on a single coat basis except where individual areas have rusted. After preparation, it is advisable to apply two undercoats to such areas before finishing.

It is recognized that numerous structures have been erected for service which were given a single shop priming coat and a single finish coating after erection. Where conditions are favorable, such as those existing in interiors of buildings that are warm and dry so that moisture does not condense on the structure, such a program may be defensible and a long time protection assured. However, there are other interiors or localized areas of interiors where, for example, moisture from products of combustion may collect and, consequently, even a three-coat job will not stand up as well as the two-coat job under more favorable conditions.

It is well not to be dogmatic on the subject of the optimum number of coats. Other factors may influence decisions; for example, the anticipated permanence of the structure, decorative considerations and the degree of importance of permanent, 100 per cent protection. There is one advantage of a three-coat system, however, which should be recognized. The use of different color pigmentation for different coats not only assists in assuring adequate coverage, but also serves as a device to warn that prompt repainting is necessary if extensive surface preparation is to be avoided.

There are many modifications of paint formulas which can be recommended to give satisfactory service for any particular job. Because of this flexibility, it is understandable that manufacturers of various raw materials may, and do, recommend formulas to promote the products in which they are interested. Nevertheless each composition possesses, in some degree, certain attributes which should be considered in selecting a paint for a given purpose. No attempt will be made here to cover the field of paints or even all compositions which might be applicable to the many problems of steel plant maintenance; rather, an attempt will be made to simplify the process of selecting a type by a classification of paints, together with a reference to the desirable characteristics of recognized types, particularly those with a high degree of protective merit.

For the purpose of discussion, paints may be classified as follows:

1. Oil and pigment paints including long oil synthetics.
2. Varnish and pigment paints, including short oil synthetics, which can be called enamels.
3. Pitch paints which are solutions of pitch such as coal tar and asphaltum in a volatile solvent such as mineral spirits, turpentine, or coal tar light oil.
4. Lacquers which are combinations of nitrocellulose solutions, plasticizers, resins, and coloring matter.
5. Water paints, which are combinations of various glues, whiting, and color pigments, and, more recently, resin emulsions with water in the external phase of the molecule.

Lacquers are of very little interest in plant maintenance work because they contain approximately 75 per cent volatile matter and require application in numerous coats under most favorable conditions to produce desirable results.

Water paints are recommended for application on accoustical material surfaces in offices, otherwise they have little significance here.

Oil paints adhere to steel surfaces better than do the enamels, which is one of the reasons for their continued importance as primers, especially for exterior structures.

The standard vehicle in oil paints is linseed oil and the pigments in general use are red lead, lead chromate, blue lead, zinc oxide, zinc chromate, titanium dioxide, iron oxide, graphite and lampblack with or without filler such as asbestine (magnesium silicate) silica, chjna clay and whiting.

Red lead, blue lead, and zinc oxide are basic pigments and react with linseed oil to form metallic soaps called linoleates. Titanium dioxide, iron oxide, graphite and lampblack are inert and therefore do not react with the linseed oil. The lead and zinc oxide plants containing the metallic soaps form dense films and are more water resistant than paints produced with linseed oil and inert pigments.

Red lead and linseed oil paint has the adhering qualities of linseed oil paint with the added water resisting quality of the metallic soap formed in the paint coat as well as certain rust inhibitive qualities due to its chemical composition. It is highly recommended as a primer where moisture and corrosive conditions are severe.

Iron oxide, when used for finish coats, has been proven over many years of service to produce a very durable paint in the weather, and has been used successfully as a primer where the moisture and corrosive conditions are not extreme. Frequently lampblack is added to produce a distinctive color and to increase durability. The darker a paint, the more resistant it is to deterioration by the sun's rays.

The carbon pigments, graphite and lampblack, are inert and form extremely soft coats with linseed oil with comparatively little water resistance and no chemical rust inhibitive qualities. Therefore, they are not adaptable for primers, but are durable as finishing coats in the weather. Much better moisture impermeability can be secured with these carbon pigment paints when a long oil synthetic vehicle is substituted for linseed oil.

Aluminum pigment is very durable and when used with a suitable vehicle is recommended for finishing coats. It is not recommended as a primer.

The primary function of a primer is to protect steel from corrosion. Red lead in linseed oil is the most commonly used primer, but is characterized by slow drying and relatively poor impermeability until the film has thoroughly oxidized. It is possible to hasten the drying cycle by the substitution of boiled linseed oil or long oil alkyd resin for a portion of the raw oil, at no sacrifice in durability. Oil varnishes have sometimes been employed for the same purpose at a slight sacrifice in durability when unprotected by top coats.

Combinations of red lead and iron oxide have proven very satisfactory, particularly from the standpoint of durability when unprotected by top coats. Zinc chromate, usually in combination with iron oxide, provides a satisfactory primer at considerable saving over lead primers in the current market. It offers some advantage over a lead primer in freedom from toxic fumes where structural components are assembled by welding. Zinc chromate is more soluble than red lead and is therefore not recommended under conditions of extreme moisture, except when dispersed in a vehicle of high moisture impedence such as a phenolic resin.

The primary function of the finish coats is to protect the primer and to provide decorative value to the structure. A properly formulated finish coat combines pigments of known durability which provide long term protection without cracking, fading, or excessive chalking. The vehicle for exterior finish coats for wood is usually linseed oil. For exterior steel, however, the harder finish which can be secured by the admixture of an oil varnish, or the use of a properly formulated alkyd resin vehicle will develop better resistance to moisture passage and therefore provide better protection for the primer.

For mill or shop interiors, where color or sustained appearance is a consideration, hard drying enamels are preferred, from the standpoint of variety of selection, drying time, and ease of cleaning. For relatively clean mill areas, such as offices and machine shops, the use of an eggshell or semi-gloss finish provides better light diffusion. Gloss finishes are preferred for dadoes and mill areas where air borne dirt is prevalent.

For normal interior exposure, the product which combines the optimum qualities of resistance to dirt collection, ease of cleaning, and color and gloss retention should be selected. For unusual conditions such as acid, alkali, oil and grease resistance, special finishes may be required which might include some sacrifice of otherwise desirable properties in order to provide resistance to the particular environment or service conditions. The vinyl compositions are highly recommended for their resistance to the attack of acid, but do not possess a good degree of adhesion so that special surface preparation such as sand blasting is required if they are to be used successfully. The phenolic resins have better adhesion with a slight sacrifice in acid resistance and continue to be used in large quantities.

The asphaltum and coal tar pitch paints possess a good degree of resistance to the attack of acids when applied in sufficiently heavy coats. They have, among other disadvantages, poor light reflective value and are generally not used where a pigment and vehicle paint is satisfactory. They are frequently used, for example, in pickle houses, metal roofs and on surfaces of items buried underground such as pipes. Some compositions include asbestos fiber to improve the structural stability of the coating over a wider range of temperatures.

Straight pitch materials, applied hot by mopping, have been used to extend the life of corrugated roofs which have begun to deteriorate. One method is to sandwich a material such as felt or canvas between two such coats taking necessary precautions to insure that the material conforms to the corrugations and is in actual contact with the first applied coat.

There is a special paint on the market which is fire protective to a degree when applied to wood or other combustible material. When flame impinges on the coating, large, cohesive blisters form, thereby insulating the underlying material from the flame.

The protection of corrugated sheeting is a large item in the maintenance of the average mill building. Because it is so thin in comparison with other structural members, its life is relatively short once corrosion begins.

After erection, it is impossible to repaint the overlapped areas and frequently impractical to paint the underside of roofs. Any moisture penetrating the areas between overlapped sheets is likely to be trapped, and these areas are thus exposed to the influence of moisture over longer periods than the remainder of the surfaces. In buildings where moisture condenses on the inside surfaces, the protruding upper edge of the overlapped sheet will tend to favor the retention of condensate. Sheets on roofs frequently corrode through from the underside along this edge, the first indication of attack being a series of pin holes through the metal and an otherwise sound layer of exterior paint.

For these reasons, the many factors contributing to the serviceability of corrugated sheeting have been the subject of numerous individual investigations. The following generalized statements appear to be warranted if maximum service is to be obtained:

1. Mill scale should be removed from sheets before painting.
2. Pickling, washing, priming and baking of sheets provides an excellent foundation for finishing coats.
3. Little, if any, additional benefit is to be obtained

by the use of rust inhibitive washes after pickling, except insofar as they afford additional protection by enhancing the corrosion resistance of the metal. They may be beneficial if it is necessary to delay painting after pickling.

4. If galvanized sheets are used, satisfactory adhesion may be obtained by permitting them to weather, treating them chemically, or by using a special zinc dust—zinc oxide primer before finishing coats are applied.
5. The heavier protective films possess much better durability. As lapped areas cannot be painted after erection, and as they may be subject to more severe corrosive influence than the remainder of the sheet, it is advisable to give them an extra coat, or coats, before erection.
6. Care should be exercised in the handling of sheets during erection to prevent damage to the film.

In recent years, industry has become increasingly aware that color, judiciously applied to working areas, significantly improves the worker's performance and attitude when the task requires a high degree of sustained visual acuity. This advantageous manipulation of optical principles, variously referred to as "Color Conditioning" or "Color Dynamics" by paint manufacturers interested in its promotion, has been thoroughly studied and evaluated, so that, when applied under the direction of qualified personnel, the machines, walls, ceilings—in fact the entire interior of shops may be colored to produce a more favorable working environment. Statistics are available to show that where this has been done, production has increased, fewer mistakes have occurred, and the general morale of employees has improved as evidenced by decreased absenteeism and labor turn-over and improved safety performance.

These benefits are the result of the elimination, insofar as possible, of conditions contributing to eyestrain. The consequences of prolonged eyestrain are many: general fatigue, increased muscular tension, irritability and headaches, to name but a few.

Any condition of seeing that causes prolonged tension of any of the eye muscles or requires continual readjustment of any of the elements comprising the eye, causes eyestrain. By providing the proper brightness level at the area of the task (and the minimum values, expressed in foot candles, have been determined for a number of industrial operations), by the use of color contrast to distinguish the focal object (the work) from the immediately surrounding area, by eliminating sharp brightness contrasts from the entire visual field, and by eliminating glare and gloom in general, eyestrain may be minimized.

To accomplish these objectives, in a machine shop for example, recommendations generally assume the following pattern:

1. On walls in the line of vision of the operator, use a color that combines the correct light reflective value, usually 35 to 50 per cent, and natural eye rest qualities such as an appropriate shade of light green. Also, use a material with a semi-gloss or eggshell finish so that the reflected light will be adequately diffused.
2. Paint wall dadoes a darker soil-resisting color using a gloss finish to facilitate cleaning.
3. Paint the stationary parts of the machine a practical soil-resisting color with slightly, but not appreciably, lower reflective value than the wall background. A slightly darker shade of green than that of the wall or a gray may be used here.
4. Paint the critical or moving parts of the machine a color that commands attention, and also provides a favorable contrast with the work and with the balance of the machine; that is, a double contrast. A light buff is generally used.
5. Walls that are not in the line of vision of the machine operator may be made more cheerful by the use of a yellow tint.
6. Where indirect lighting is used, paint the ceiling the lightest color consistent with practical dictates to avoid wasting light. With direct lighting, a receding color such as an appropriate shade of blue may be advisable.
7. Finally, color should be employed as a safety factor. High visibility colors such as yellow and orange should be used to warn of danger. The conventional yellow and black stripe should be used on the surfaces of objects, moving or stationary, that introduce an element of hazard in the working area.

In certain instances, color may be used for purely psychological effects. For example, a cool color such as blue when used on interiors where workers complain of the heat, or a warm color such as orange when used in areas where workers complain of cold or draught, actually contributes to the worker's comfort by its suggestive influence.

Many machine operations do not require intense visual effort over prolonged periods, hence the value of such a program is less obvious. However, so long as paint is to be used on interiors, it may as well be functional as color has very little, if any, influence on its applied cost.

It is to be remembered that paint materials for shop interiors should be selected with reference to their resistance to attack by lubricating oils, grease, cutting oils or any other questionable materials common to the environment.

The influences to which paint films are exposed frequently vary from time to time and may not be well defined; consequently, laboratory tests have a limited value in determining the most effective methods and materials. Fortunately, paint tests at the actual site under consideration are generally inexpensive and easy to conduct, so that much worthwhile information may be obtained from such investigations.

The increased demands made on paint films by prolonged contact with water, particularly if the water carries chemicals in solution, has been emphasized. Consequently, if an item requires the protection of paint for lasting service, any design that eliminates the collection of water is worthy of consideration.

The substitution of other types of protective films for paint may be advisable in some instances when appraised on a long time basis. There are some paint problems to which the only practical solution appears to be more frequent repainting than might reasonably be desired.

INCREASED OPEN HEARTH PRODUCTION BY IMPROVED CHARGING METHODS

. . . . open hearth charging time will be decreased, in all probability, through improvements in a number of apparently minor items rather than through any radical changes in design . . . .

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▲ TO many observers the conventional method of charging open hearth furnaces is not an efficient operation. In most instances the defects are easily recognized. For example, the simultaneous charging of scrap in adjacent furnaces frequently results in charging delays or a greater number of furnaces may require hot metal at any one time than there are cranes available for its delivery.

A complete solution of these and many other problems would require an entirely new arrangement of an open hearth plant which in turn may present other undesirable conditions of even greater magnitude than those currently existing. An idea of this may be found in the frequent suggestion that a furnace equipped with a removable roof or front wall which could be charged in a single operation without interfering with an adjacent furnace. It should be noted, however, that such a method of charging applied to heats being made by the flush slag practice would probably result in an extremely long heat time because of the difficulty of heating the ore and limestone on the bottom of the charge. Furthermore, most open hearth plants are not capable of being radically changed except by a very considerable expenditure, which probably could not be justified. For these reasons, first, that a radical departure from the conventional method of charging places one in the realm of speculation, second, because such departures may not be economically justified if applied to existing plants, this paper confines itself to an analysis of the current method of charging and suggestions whereby present facilities can be altered or augmented so that the accepted charging procedure can be used with greater efficiency.

ANALYSIS OF CHARGING PROCEDURE

The most important factor in charging an open hearth furnace is timing. The charge materials consisting of scrap iron and steel, burnt lime or limestones, iron oxide as iron ore or sinter, pig iron either in the molten or solid state and possibly coke, should be added to the furnace at such intervals to produce the minimum charge-to-tap time of the heat being produced and also the maximum yield. There are numerous variables that determine what the intervals should be, the more important being as follows:

1. Percentage of hot metal in the charge.
2. Percentage of cold pig iron in the charge.
3. Physical characteristics of the scrap.
4. Furnace dimensions.
5. Fuel.
6. Age of the furnace.

Regarding these variables the following should be noted with respect to their influence on the time for charging the various materials in the furnace.

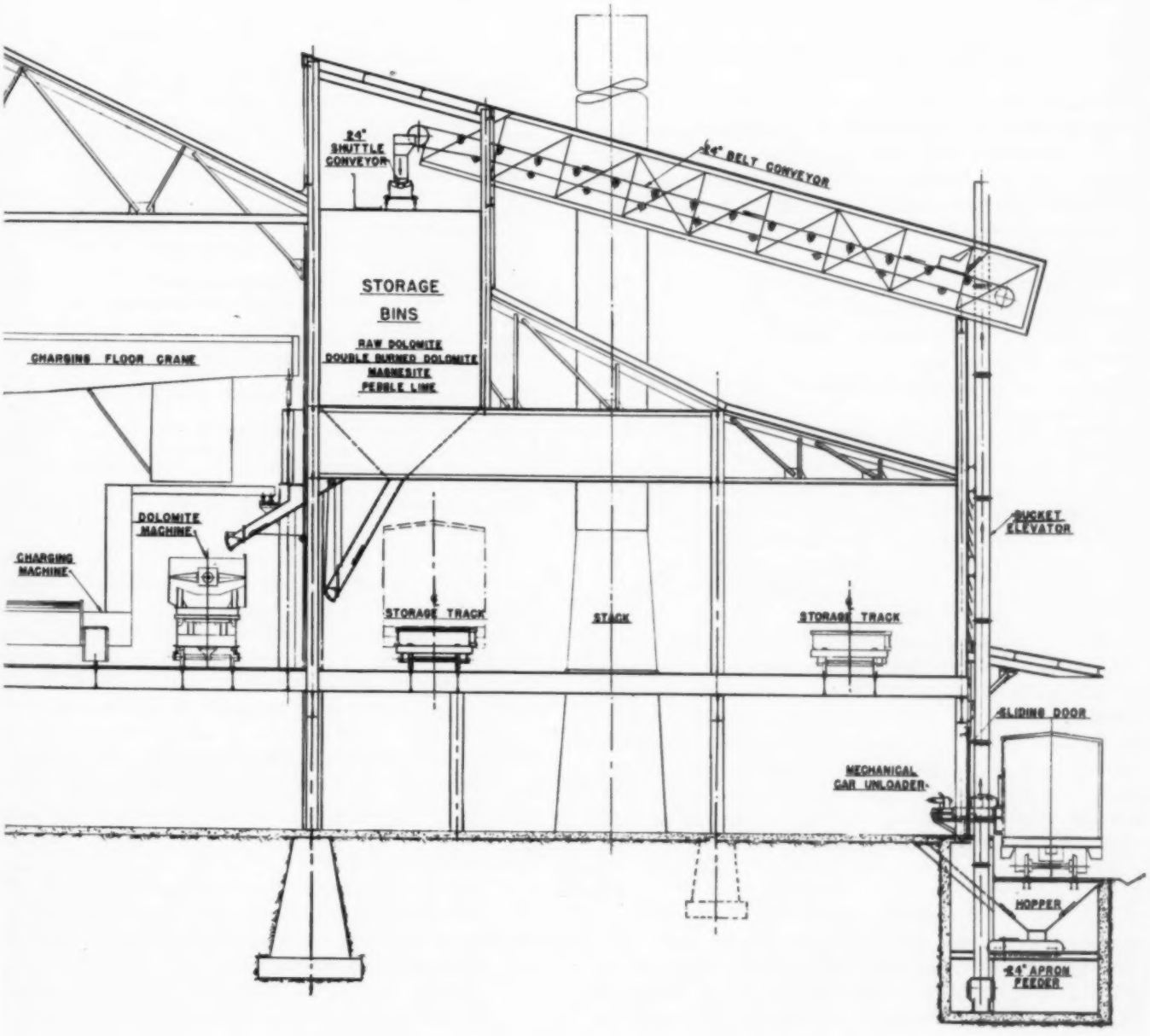
1. When the percentage of hot metal in the charge is greater than approximately 45 per cent, it is necessary to charge ore or sinter along with the other materials and to remove some slag, known as the flush slag, during the ore boil which follows the addition of hot metal. In order that the charge-to-tap time of a heat be kept at a minimum and the yield as high as possible, it is necessary to have the cold charge material consisting of scrap steel, iron ore or sinter and limestone at the correct temperature when the hot metal is added. If the cold charge is at too low a temperature, the flushing off of the slag will be slow and the charge-to-tap time long. If the cold charge is too hot, then there may be a loss of metal due to an excessively violent ore boil, with a resulting low yield.

   In order to be assured that the cold charge material is at the correct temperature, it is frequently necessary, particularly when there is more than 60 per cent hot metal in the charge, to interrupt the charging after the limestone and ore or sinter and some scrap are added. This allows those materials to be heated by radiation and convection, rather than by the slower means of conduction through a thick layer of scrap. If charging were not interrupted, it is highly probable that the ore or sinter and limestone would be too cold to give a rapid flush even though the scrap appeared to be at the correct temperature.
2. As the percentage of cold pig iron in an all cold charge is reduced, the usual interval between the last addition of the scrap steel and the first addition of the pig iron can be reduced. Finally, if furnace dimensions and the character of scrap permit, and if no iron is used, charging can be continuous.
3. The physical characteristics of the scrap steel may be such that the furnace hearth will be tempor-

arily filled before all the scrap is added. Charging then must be interrupted to allow the material to melt down so that further additions of scrap can be made.

4. Furnace dimensions may be such that charging of scrap steel must be interrupted to allow the scrap charged to melt down. If this is not done the refactory roof of the furnace may be damaged because the flame is deflected by the scrap to the roof.
5. Fuels vary widely in their ability to heat and melt the various charge materials. In general, a fuel such as oil or natural gas, having a high Btu content and producing a highly luminous flame will melt scrap steel more rapidly than a low Btu fuel such as producer gas or a fuel like coke oven gas which produces a nonluminous flame. Consequently fewer and shorter interruptions in charging will be required if a fuel having a high Btu value and producing a luminous flame is used. With respect to the fuel and the timing of the charging operation the effect of using oxygen to enrich the flame should also be noted. Oxygen, when used for flame enrichment, materially increases flame temperature which in turn increases the rate of heat transfer and consequently the rate of melting scrap. It is of interest to note that the reported increase in the theoretical flame temperature when pure oxygen replaces air for the combustion of fuel oil is from 3780 F to 5440 F. Since the rate of heat transfer by radiation between two substances is proportional to the difference of the fourth power, of their absolute temperatures, the effect of raising the flame temperature on the rate of melting scrap is considerable.
6. The age of a furnace affects the rate at which it will melt scrap. For the first 25 or 30 heats of a furnace's life, the rate of firing should be some-

Figure 1 — Bulk material loading and storage system for open hearth plant.



what less than normal with a consequent low rate of scrap melting. This is followed by a considerable period when the ability of the furnace to melt scrap remains relatively high and constant. Finally, during the last 25 or 30 per cent of the furnace life, there is a gradual increase in the time required to melt scrap. It should also be noted that the rate of firing may be temporarily reduced for a brief period after certain refractory repairs, particularly those to the roof.

These comments on certain of the variables which affect the timing of the charging operation indicate that if two general conditions are met, any further increase in the efficiency of the accepted charging procedure can hardly be expected. These two conditions are:

1. The charge materials must be available when required to the equipment used for adding those materials to the furnaces.
2. When material is required by a furnace, it should be added as rapidly as possible.

It should be noted that it is not necessary to always provide for continuous charging, nor is it even necessary to keep the total time of the charging period at a minimum.

ALTERATIONS AND ADDITIONS

In order to meet these two general conditions in the greatest possible degree, certain items of plant equipment and layout should be examined and an appraisal made as to their limiting effect on the charging operation. The most important of these items are as follows:

1. Track layout.
2. Scrap preparations facilities.
3. Charging boxes and cars.
4. Furnace charging doors.
5. Cranes and charging machines.
6. Hot metal ladles.
7. Hot metal storage facilities.
8. Locomotives.
9. Buildings and crane runways.

While in most plants some or all of these items will be found to have a limiting effect on maintaining efficient charging, it is frequently possible to make changes which will tend to remove the limitations. Sometimes, the changes may be uneconomical when the gains are considered; however, in most instances this can be determined by analytical methods.

The balance of this statement is a discussion of several of the changes that can be made to the aforementioned limiting items that will improve charging efficiency, together with some suggested analytical methods whereby it is possible to determine whether a change is or is not economical. It should be noted in this discussion that the various items are treated separately only to the extent possible since it is obvious that they are closely interrelated.

TRACK LAYOUT

The railroad tracks which are utilized in the movement of the charge materials should be of sufficient length to provide adequate storage for the trains of material, and so arranged that free movement of the trains is possible. Also, the storage tracks should be correctly distributed as to storage for trains of material to be charged, storage for empty trains and storage for trains being loaded. A suggested means of determining whether the tracks of a plant are adequate for the charging operation and also what changes and additions, if any, should be made, is shown by the following example: Assume a plant of the twelve 160-ton open hearth furnaces with a stockyard independent of the open hearth building, and a high line leading from the stockyard to the charging floor level. This plant uses a flush slag practice on about 80 per cent of the heats. Based on actual operating data of several plants, 525 cars of cold charge material will be charged every 24 hours during periods of capacity operations. Based on this and other data which are readily obtainable at any plant, the following Table I has been prepared showing the required length and distribution of the storage tracks necessary to avoid charging delays during a condition of so-called "bunched heats," when six heats are charged in a period of four hours.

TABLE I

STORAGE TRACK REQUIREMENTS

Number of cars per heat for cold charge — average	21.0
Number of heats per 24 hours — average	25.0
Number of cars to be charged in 4 hours — 6 heats charged	126.0
Number of hours per complete car movement cycle (from time studies)	4.52
Number of hours per cycle car is on charging floor level (from time studies)	2.05
Number of furnaces charging at one time — all charging machines in use	3.0
Number of cars in front of furnace at one time — 50 per cent of cold charge	32.0
Number of cars required on charging floor level	65.0
Number of cars required to be stored on charging floor, not in front of furnaces	33.0
Number of cars charged per 0.52 hour cycle — average	12.0
Number of cars of feed ore required per 4.52 hour cycle — average	3.0
Number of miscellaneous cars required to be in service	25.0
Length of car — ft	14.0
Length of storage track on charging floor level — ft	462.0
Total number of cars required to be in service	232.0
Number of cars on ground level — no furnaces being charged	199.0
Length of required ground level storage tracks — ft	2780.0

The principal items to note in Table I are the requirements for 462 ft of storage tracks on the charging floor level and 2780 ft of storage tracks on the ground level. Also to be noted, which will be discussed later, are the 232 charging cars required to be in service. Since the building of a 12-furnace open hearth plant is at least 900 ft long, the 452 ft of required storage tracks on the charging floor level may be available in the lean-to structure generally found in back of the main charging floor. However, if such storage tracks are not available, it is frequently possible that certain alterations will provide the necessary tracks. Typical of these alterations are the following:

1. A track currently being used for the unloading of miscellaneous supplies on the open hearth charging floor can be made available for the movement and storage of charging box cars if other means of delivery of the miscellaneous supplies is found. This may involve the construction of an unload-

ing dock on the ground level, and the installation of elevators for lifting the various materials to the charging floor level. It may also mean that many materials will be stored on the ground level under the charging floor, and that mechanized equipment such as fork lift trucks and shovel trucks can be used to great advantage in handling the miscellaneous supplies. Also certain materials such as those that are used in the dolomite throwing machines and burnt lime for furnace additions may be unloaded from cars mechanically, and stored overhead in bins built into the building framework. A typical example of an installation for the mechanical unloading of bank and bottom repair materials and burnt lime and the transport to and storage of those materials in overhead bins is shown by Figure 1.

Time studies and other data indicate that in the 12-furnace plant used as an example the method shown by Figure 1 for unloading the bank and bottom repair materials and burnt lime and storing same in overhead bins will reduce the handling time of those materials from 412 man-hours per month to 65 man-hours. This is a gain beyond the prime purpose of installing the unloading and storage facilities, which is to release the charging floor level tracks on which the bank and bottom repair materials and burnt lime have been unloaded. The use of fork lift trucks, shovel trucks, and elevators will, based on time studies and other data, reduce the time for handling ferro-alloys, brick and other materials in a shop of twelve 160-ton furnaces from 2200 man-hours per month to 1050. This again is a gain beyond the prime purpose of changing the location of the material unloading track.

2. Curves of shorter radius may be installed thereby decreasing the length of crossovers between tracks and making more track available for storage. This is almost always possible when diesel-electric locomotives replace steam locomotives for handling the trains of charging cars. The reason for this is that most diesel-electric locomotives are of articulated construction and can operate around curves of much shorter radius than steam driven locomotives of the same size.

The required 2780 ft of storage tracks on the ground level includes the tracks used for loading the charging cars. It does not include any of the running tracks nor the tracks used by the inbound cars of scrap, iron ore, limestone and other materials. If, on analysis a deficiency of ground level storage tracks for charging cars is indicated, it may be possible to find space for additional tracks by removing some or all of the scrap steel that is frequently stored in under the stockyard crane runway. Storage of scrap under the stockyard crane runway is a precaution against not having scrap available for charging, because of the inability for any number of reasons to move standard railroad cars of that material under the runway.

Storage of scrap does not to any great extent eliminate double handling of the material, because the available area under a stockyard crane runway will seldom hold more than a 10 days supply of scrap. This is less than 25 per cent of the usual inventory held in a plant.

SCRAP PREPARATION FACILITIES

Scrap preparation facilities are the second item of plant equipment and layout that should be appraised with respect to their limiting effect on charging operations. It is obvious that bulky scrap can, by increasing the length of trains, make it more difficult to have the charge materials available when required.

Also, and more important, bulky scrap requires a longer time to charge, and may necessitate repeated interruptions in the charging operation because the

TABLE II

DESCRIPTIVE DATA OF SCRAP BALING INSTALLATIONS

Item	A Conventional baling press installation	B Large press in steel works scrap yard	C Large press in scrap dealers yard
Average size of bale — in.	22 x 20 x 16	60 x 24 x 24	30 x 72 x 30
Average weight of bale — lb.	700	3000	5000
Average density of bale — lb per cu ft	172	150	133
Maximum allowable thickness of material — in.	⅛	¼	¼
Size of press loading pit — in.	85 long 51 wide 37 deep	120 long 24 wide 180 deep	204 long 72 wide 84 deep
Number of directions of compression	3	2	2
Method of transmitting compressive force	Hydraulic	Mechanical	Hydraulic
Compression time — min	1.5	5.0	1.5
Total time per bale — min	2.5	5.6	6.0
Press capacity — tons per hr	8.4	16.1	25.0
Operating hp	75	275	300
Type of loading crane	Crawler	Bridge	Crawler
Type of loading equipment	Magnet	Magnet	Orange peel bucket
Loading hopper	Yes	Yes	No
Loading time — min	2.5	2.0	4.5
Method of handling bale from press	Conveyor loads into railroad car	Pushed directly from press onto charging peel	Loaded by bridge crane into railroad car
Number of operating personnel	4	3 or 4	8 or 9
Operation limiting production	Loading	Compression	Loading

furnace cannot hold the bulky material. A particularly effective item of equipment to transform bulky pieces of scrap into a highly satisfactory form is the baling press. Generally, presses are operated by the scrap dealers and because of the high initial investment and because a dealer must produce a bale that will fit in several sizes of boxes, the presses are relatively small. Consequently, the material that is baled cannot be too large or thick. There are, however, a few installations in this country of baling presses which are capable of handling large thick pieces and produce bales approximately the size of charging boxes. A comparison of two of these presses with the conventional press of a scrap dealer is shown on Table II.

Regarding these three installations the following is of interest to note:

1. Press "A" which has a loading hopper is limited in production by the rapidity with which the hopper can be loaded.
2. Press "B" which also has a loading hopper, is limited in production by the relatively slow mechanical means of transmitting the compressive force.
3. While both press "A" and "B" have loading hoppers, the bridge crane used at press "B" will load scrap into the hopper about five times as fast as the crawler crane at press "A."
4. Press "C" which does not have a loading hopper is limited by the time for loading plus the time for compression.

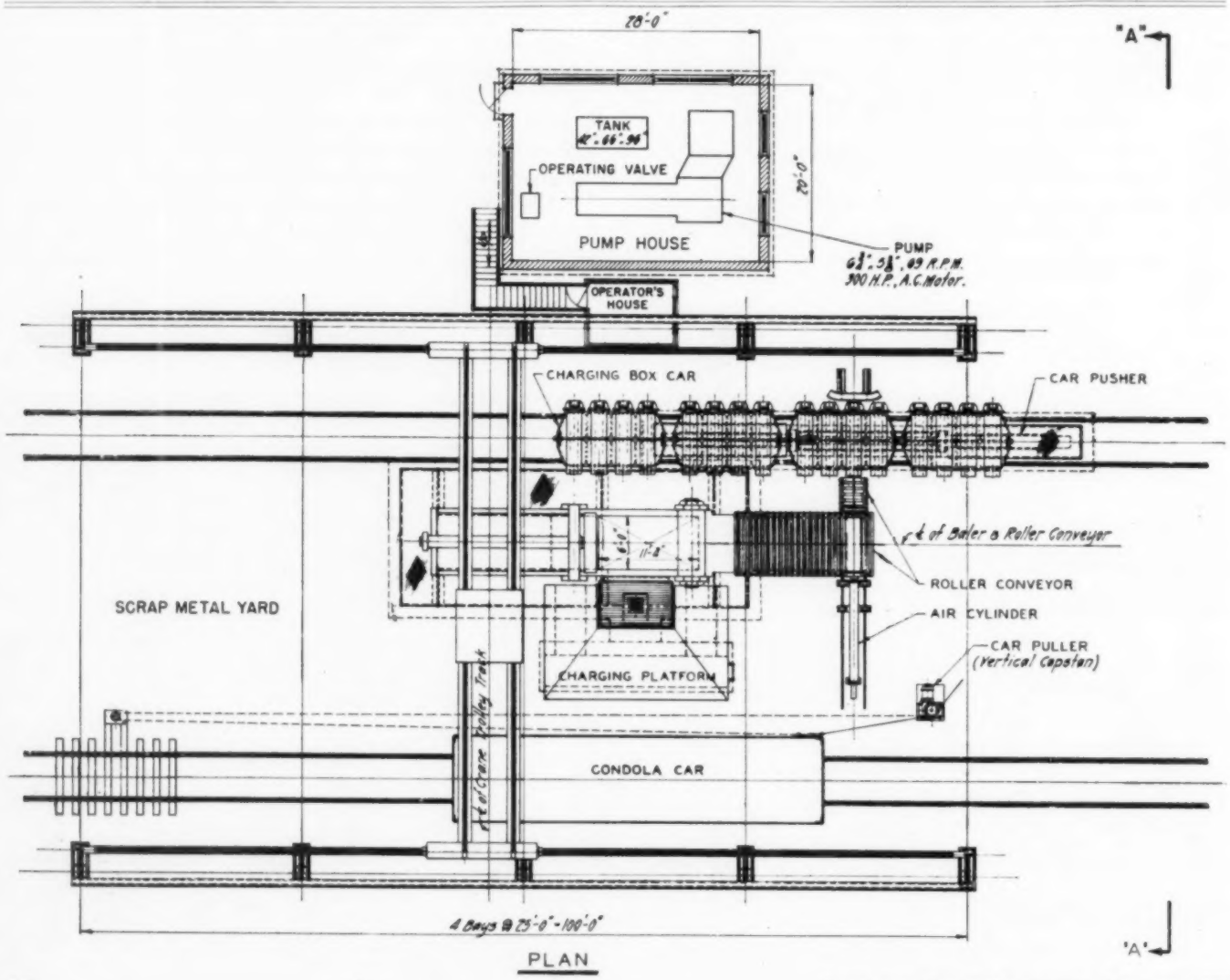
From these observations together with the data shown on the table a suggested baling plant has been designed. Figure 2 shows this proposed plant.

This plant is designed to be located in the works of a steel producer. It includes a loading hopper which together with hydraulic compression provides the most rapid method of producing a bale. It loads the bundles directly into charging peels located on the charging cars, thereby eliminating double handling and reducing the possibility of the bales breaking open. A comparison of the operating personnel for this proposed plant compared with those for presses A, B and C is shown in Table III.

The production rate of this proposed plant will be about 40 tons per hour when producing a 22 x 34 x 72-in bale. The estimated operating cost of this plant is shown on Table IV.

This cost of $0.40 per ton of scrap should be compared to the cost of preparation by shearing or burning which may be as high as $3.00 per ton for light, bulky material.

The increase in ingot production that may be expected by charging material having a high unit weight in contrast with light, bulky material will be discussed later under charging boxes, since any increase in weight per box will decrease the number of boxes to be charged,



PLAN

TABLE III

COMPARISON OF OPERATING PERSONNEL — SCRAP BALING PLANTS

Duties or position	Press "A"	Press "B"	Press "C"	Proposed plant
Loading crane operator	1	1	1	1
Press operator	1	1	1	1
Pump room attendant	None	Not required	1	1
Discharge crane operator	Not required	Not required	1	Not required
Ground labor and burners	2	1 or 2	2	2
Labor in inbound cars	None	None	1 or 2	None
Labor in outbound cars	None	Not required	1	Not required
Total Maximum	4	4	9	5

TABLE IV

OPERATING COST — SCRAP BALING PLANT

Item	Cost per ton of scrap
Operating labor	$0.20
Supervision and overhead	0.05
Power	0.03
Maintenance, lubrication and misc. supplies	0.02
Depreciation	0.10
Total cost	$0.40

and thereby reduce the charging time. Data taken from actual stockyard records indicate that the average density of scrap in a charging box is about 85 lb per cu ft. However, the material which should be baled, loaded in a loose condition will have a much lower density. Assuming this latter density to be about 60 lb per cu ft and the density of a large bale to be about 133 lb per cu ft, the installation of a baler is the equivalent of increasing the size of the containing charging boxes by 122 per cent.

In addition to the installation of a baling press, existing scrap preparation facilities can frequently be improved and thereby indirectly improve charging operations. In most steel works, scrap preparation facilities consist of a shearing and burning yard or yards. Crane service in these yards may be provided by bridge, gantry, locomotive or crawler cranes. If space permits the gantry crane is generally to be preferred and for the following reasons should, where possible, be installed:

1. The installation cost of a gantry crane is less per square foot of work area than for a bridge crane. This is shown on Table V.

TABLE V

COMPARISON OF COST OF INSTALLATION OF GANTRY CRANE VS BRIDGE CRANE

Dimensions, ft	Area, sq ft	Installation cost per sq ft of area	
		Bridge crane	Gantry crane
80 x 300	24,000	$7.09	$4.27
90 x 400	36,000	5.92	3.00
100 x 500	50,000	5.20	2.36
110 x 600	66,000	4.70	1.93
120 x 700	84,000	4.34	1.71

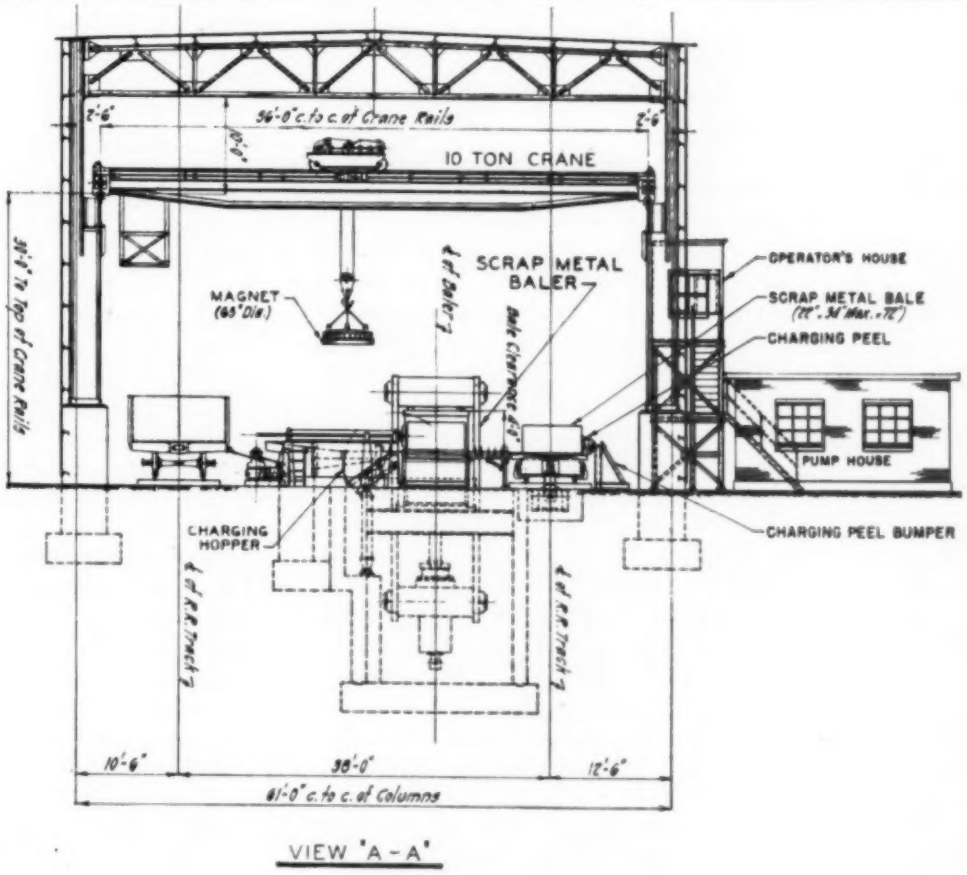


Figure 2 — Scrap metal baling yard. On left is shown a plan view, and on the right is shown a right elevation.

2. The slow bridge travel of a gantry crane compared with a bridge crane is not an important item of consideration in selecting a crane for a scrap preparation yard. This is clearly indicated in data compiled by the Association of Iron and Steel Engineers which show that the bridge of a crane servicing a scrap preparation yard will only operate 10 per cent of an operational hour. This is much less than the 44 per cent for a hot metal crane, 45 per cent for a ladle crane, 30 per cent for a stockyard crane and 42 per cent for a cinder yard crane.
3. A gantry crane is more efficient than a locomotive crane. This is shown on Table VI which is based on actual observations.

TABLE VI

COMPARISON OF PRODUCTIVITY

GANTRY CRANE VS LOCOMOTIVE CRANE

SCRAP BURNING AND SHEARING YARD SERVICE

	Gantry crane	Locomotive crane
Rate of loading, unloading and moving scrap, loads per min	3.24	2.52
Average weight of scrap per load, lb	2300	1500
Average speed of bridge travel, fpm	43	220
Average time loading, unloading and moving scrap, min per hr	46.5	53.2
Average time moving to different work areas and switching cars, min per hr	7.6	0.9
Average time idle or being serviced, min per hr	5.9	5.9
Relative productivity Locomotive crane = 1.000	1.72	1.00

4. A crawler crane cannot conveniently switch cars, and has a much slower travel speed than a locomotive crane.

The location of the scrap shearing and burning yard should also be considered. If an area is available, the yard should be so located that the prepared scrap can be loaded directly into the charging boxes.

CHARGING BOXES AND CARS

Charging boxes can frequently be increased in cubical capacity, thereby reducing the actual time required to put a given quantity of material into a furnace. This reduction is reflected in a reduction in the charge-to-tap time of a heat. It can be shown by analytical methods that the charge to tap time of a heat will be reduced by 50 per cent of the reduction in time to put the cold charge into the furnace through the use of larger charging boxes. Published data based on 1155 heats have verified the analytical methods.

An illustration of what may be expected with respect to an increase in ingot production when the size of charging boxes is increased is shown on Table VII.

The data shown on this table can also be applied to the use of large bales of scrap in the charge where the increase in weight per box is the equivalent of increasing the cubical content of the box.

There are a limited number of ways by which a charging box can be increased in capacity. The cross-sectional area can be increased and/or the box can be lengthened. Due to the fixed location of the furnaces and charging tracks the latter means is seldom feasible. Increasing the cross-sectional dimensions is often possible; however, in most cases, a change to the furnace charging doors is required. One possibility that does not require a change to the doors is to widen the bottom of the boxes which in turn reduces the side taper. Boxes with a side taper as low as six degrees from the vertical are giving satisfactory service while in many plants a side taper of 12.0 degrees or more will be found.

TABLE VII

EXPECTED INCREASE IN INGOT PRODUCTION

THROUGH USE OF LARGER CHARGING BOXES

	Per cent increase in ingot production	
	Analytical methods	Operating data
Enlarge boxes from 28 to 33 cu ft	0.389	0.395
Enlarge boxes from 28 to 40 cu ft	0.745	0.789
Enlarge boxes from 28 to 46 cu ft	0.985	1.025

Changes to the charging doors that will allow a wider box require a reduction in width of the jambs between doors or a reduction in number of doors. In cold metal shops, or in shops that cannot possibly install equipment for the front flushing of slag, the reduction in number of charging doors from the conventional five to four presents a distinct possibility.

Changes to doors that will allow the use of a higher box can be found in the adoption of the so-called "archless door frame." Frequently six or more inches can be added to the height of a door opening by such a means, also the contour at the top of the door opening can be changed to a flat arch.

With respect to increasing the height of a charging box it should be noted that most boxes have a considerably greater top width than height, the average ratio being about 1.42 to 1. However, boxes having a ratio of top width to height of almost unity have been successfully used. It is suggested that if the height of a box can be increased to where it will be considerably greater than the top width, that experimental units be first tried.

While having only a minor effect on production, the use of larger charging boxes will also reduce the length of the trains of cold charge materials. This may be of considerable advantage in a plant having a limited length of tracks for the storage and movement of cold charge materials. Also it will reduce the interference between a furnace being charged and adjacent furnaces. The same holds true if the length of a charging box car is increased so that more boxes can be held on a single car. This is shown on Table VIII.

The minimum radius of the curves over which the cars must pass should be determined before any change is made to the length of charging box cars.

It is important that an adequate number of charging boxes and cars be available at all times to prevent charging delays. Data obtainable from various operations indicate that about 7.0 cu ft of charging box

TABLE VIII

COMPARISON OF LENGTH OF TRAINS

Item	Length of train ft
84-Box train — 2 Boxes per car	356
84-Box train — 3 Boxes per car	314
84-Box train — 4 Boxes per car	294
84-Box train — 5 Boxes per car	289
84-Box train — 6 Boxes per car	267

capacity per ton of cold charge material charged per 24 hours are required to prevent delays from lack of boxes. Cold charge materials include scrap, ore or sinter and limestone. Additional boxes will be required if crop ends and other mill scrap are loaded into charging boxes at the mill. Also there should be a small number of boxes, approximately three for every furnace available for handling feed ore and other furnace additions. There should be sufficient cars for all boxes plus an additional 10 per cent to provide for the transport of miscellaneous supplies such as tapping bars and also to allow for repairs to cars.

CRANES AND CHARGING MACHINES

In the majority of plants the principal cranes that effect the charging of the open hearth furnaces are the stockyard cranes and the hot metal transfer cranes. Generally stockyard cranes do not limit production and if it appears they do, a study by the plant industrial engineers can readily determine whether an additional crane is required or that the speeds of the existing cranes should be increased.

The hot metal transfer cranes however present a different type of problem. Here crane capacity is frequently a limiting factor. In many plants the size of furnaces have been greatly increased over their original design capacity, and in others the installation of additional blast furnaces have required that more hot metal be used. The result has been that the hot metal cranes, due to a limited carrying capacity, must transport two or three ladles of hot metal to a furnace for a single charge. This means that hot metal is not always added at the correct time with a resultant increase in time of heats. In many plants, due to the very considerable cost of a hot metal crane, such a condition has existed for some time. However, the "Association of Iron and Steel Engineers Specifications for Electric Overhead Traveling Cranes for Steel Mill Service" A.I.S.E. Standard No. 6 present an authoritative means by which a complete analysis can be made of the various components of a hot metal transfer crane that will determine what is required to be done to a crane to enable it to carry any particular load. Recent investigations based on the aforementioned specifications have shown that the capacity of hot metal transfer cranes can frequently be greatly increased with an expenditure that is relatively small compared with the purchase of a new crane. For example, the replacement of certain carbon steel gears and shafting with the same items made of heat treated alloy steel will frequently be all that is required, or replacing a standard railroad rail on the bridge with a crane rail and plate combination having the same height as the original rail will add the required strength to the girders.

One of the principal reasons why the capacity of a crane of the type used for the transport of hot metal can be increased by making relatively minor alterations is due to the very appreciable dead load in cranes of this type. For example on one crane of this type it has been found that a 35 per cent increase in the live load at the main hoist is only 20 per cent at the trolley wheels and 14 per cent at the bridge wheels.

The capacity of charging machines may also have a limiting effect on ingot production in that the capacity of the charging boxes may be limited by the machines. Here again the various components of the machine can be analyzed and similar changes such as those suggested for the hot metal cranes may be made which will allow a machine to handle larger boxes.

HOT METAL LADLES

Generally hot metal ladles do not limit charging operations except so far as their capacity is limited by the hot metal cranes. However, if not limited by the crane capacity, a careful appraisal should be made as to whether or not the ladles should be increased in capacity so as to reduce the number required to be charged in a heat. Also it should be recognized that a hot metal transfer ladle should be about 15 or 20 per cent oversized to allow for skulling.

HOT METAL STORAGE FACILITIES

Hot metal storage facilities consist of mixers and/or the so-called mixer type transfer cars. The location of the mixers and the transfer station for the cars with respect to the furnaces frequently affects the delivery of hot metal to the furnaces, and may make it appear that there is inadequate crane service for the delivery of hot metal when required. In many plants containing 12 or more furnaces, the mixer or mixers are located at one end of the charging aisle. Under such a condition, interference between cranes is likely to exist. Careful time studies by the plant industrial engineers can readily evaluate the loss in ingot production because of such interference between cranes. If the loss is sufficient, a mixer or transfer station for mixer type cars can frequently be installed at the opposite end of the charging aisle. By adopting a design of mixer where the iron is poured in and out the same side, only the charging aisle is required to be lengthened. Such a design of mixer has performed satisfactorily.

LOCOMOTIVES

As previously mentioned, the replacement of steam locomotives with diesel-electric locomotives will allow the use of shorter radius curves. This results from the articulated trucks generally used in a diesel-electric locomotive. As an example, an 80-ton steam locomotive requires 140-ft minimum radius compared with an 80-

ton diesel-electric which will operate around a 75-ft radius curve. Additional advantages of the diesel-electric over the steam locomotive which recommend its use for handling the charging car trains are as follows:

1. The overall length of the diesel-electric is less than the steam locomotive plus the tender. For 80-ton locomotives, the diesel-electric is 39 ft compared with 54 ft for the steam driven unit.
2. A diesel-electric locomotive has about 95 per cent availability compared with 80 per cent for the steam unit. This is important in open hearth charging operations where the demand for locomotive service is somewhat unpredictable.
3. The weight of the tender, about 50 tons for an 80-ton locomotive, reduces the hauling capacity of a steam locomotive.
4. The tractive force of a steam locomotive may, in certain instances, be limited by the size of cylinders and steam pressure, while for the diesel-electric locomotive it is always a percentage of the weight. This may allow heavier trains of cold charge material to be handled by the diesel-electric locomotive.

BUILDINGS AND CRANE RUNWAYS

Buildings and crane runways often limit open hearth furnace charging by being of insufficient strength. If the charging floor is not of sufficient strength, then it probably can be reinforced without any serious interruptions to operations. Welding the floor plates to the girders supporting charging machine and car tracks is a convenient means of obtaining a small increase in floor carrying capacity. Crane girders, particularly those over which the hot metal cranes travel, present a more complex problem, it being usually necessary to take down the girders to reinforce them or to interrupt crane travel for a long period. However, under certain conditions it is possible to splice the girders at the points over the top of the columns where they generally meet, thereby forming a continuous section of crane runway. By this relatively simple means the carrying capacity of the crane girders may be increased so that the live load on a crane can be materially increased. To do this, it is absolutely necessary that the foundations under the crane runway columns be free from any movement, also the splices must be correctly made and of sufficient strength. Allowance must also be made for expansion.

Increasing the capacity of a crane runway by the application of knee braces between the girders and the columns is definitely not recommended unless the design of the knee braces is carefully analyzed. In the past, the reinforcing of a crane runway with knee braces has usually resulted in overstressing resulting in failure of knee brace rivets or overstressing the crane runway columns at the point of application of the braces.

CONCLUSIONS

This paper has included several suggestions whereby the operations relating to the charging of open hearth furnaces may be improved, and thereby either directly or indirectly increasing ingot production. It has not attempted to completely cover every phase of the charging operation. In most instances the individual suggestions will result in an increase in production that can hardly be measured. However, a program that includes those suggestions that are applicable, plus the many others that will be suggested by operating personnel, will usually result in an increase in production and a reduction in costs far greater than the mere addition of the individual items.

DISCUSSION

PRESENTED BY

FRANK G. NORRIS, Statistical Metallurgist, Wheeling Steel Corp., Steubenville, Ohio

R. TIETIG, JR., A. J. Boynton Co., Chicago, Ill.

K. C. McCUTCHEON, Assistant to Vice President in Charge of Operations, Armco Steel Corp., Ashland, Ky.

L. S. LONGENECKER, Frazier-Simplex, Inc., Washington, Pa.

R. RUSSELL FAYLES, Fuel Engineer, Lukens Steel Co., Coatesville, Pa.

P. E. HAGLUND, Supervisor of Engineering, Ford Motor Co., Dearborn, Mich.

L. F. REINARTZ, Assistant Vice President, Armco Steel Corp.

Frank G. Norris: The highlight of the paper is that heat time is not controlled by any one thing, but as pointed out in the author's concluding remarks, any improvement that is made in heat time is probably the cumulative effect of a large number of apparently inconsequential factors. That, to me, is the outstanding summary of the paper, and I think it is pretty much a summary of our experience.

We have been fortunate in having had the services of the author's company over the past several years in the analysis of our problems, and have been able to follow through on some of the suggestions made. Many of the improvements we have made are discussed in this study.

One of the points I should like to comment on in detail is the effect of the age of the furnace. In the paper, it is mentioned that every furnace has a minimum of heat time according to age. There is a certain age when that furnace is making the shortest heats.

At the beginning of the campaign the furnace is cold, and the first few heats are long heats. We have made an analysis of furnace time by furnaces and by weeks, and have found that the minimum was during the week when there are about forty or fifty heats in the campaign. I think that is in slight disagreement with Mr. Tietig's results. As I recall, he gives the best heat time at around twenty-five or thirty heats. I think the figures are in disagreement, but maybe the difference is simply because of the difference in the method of presentation of the information.

R. Tietig, Jr.: After about twenty-five heats, you start approaching your optimum. You are not able to fire at maximum rates until you have had twenty or twenty-five heats out of the furnace.

Frank G. Norris: We find that average heat time goes through a minimum and then progressively increases. On a fast furnace the whole line will be low on the chart. On a slower furnace the minimum value will be higher and, as the furnace ages, heat time will be longer all the way through the campaign. This trend is present in any discussion of heat time. The age of the furnace during any period under study has to be taken into consideration.

Another thing is the effect of charging time. As I recall, Mr. Tietig said the factor was about a half. The way I interpret that is if you cut your charging time about an hour, you can expect an improvement in the heat time of about half an hour, and if you lengthen charging time, it will not have an equal effect on lengthening the heat time, but will increase the heat time by about a half.

We have made several studies of charging time and find two things that have to be considered, viz: charging time and the timing of the charge. An hour's prolonging of the charging time will do more damage to the heat time than excessively fast charging time will help. If the charging time is one hour below the average, it will shorten the heat time, but not very much. It is not, strictly speaking, an overall linear relationship between charging time and heat time.

K. C. McCutcheon: This paper covers a lot of important details and discusses in an intelligent way many of the things it is possible and desirable to do to make it possible to increase production.

An analysis of the type indicated in this paper made in each plant will indicate what one can afford to do, because there is considerable difference in the physical layouts of plants, and what will pay in one plant may not work in another.

The fundamentals are the same. In most plants all of the preliminary moves have been made, different for each because of different conditions when the plant was laid down. The productive capacity of the furnace has been increased by changes of fuel, furnace lines, size of hearth, use of molten metal. In each plant each has run into the same obstacle, i.e., difficulties in getting the raw material charge into the furnace without delays. Along with this has developed an understanding that further changes in the furnaces themselves and in the method of burning fuel cannot result in the full expected improvement because of inability to charge the furnaces at the increased rates necessary.

This paper very clearly lays down some of the fundamentals and suggests some of the moves that may be made to increase production in existing locations. Such a method should tell you how much must be spent to get a given increase in production. What it will cost and just what must be done will depend upon the initial layout. With these figures you can figure the effect in production cost and the capital outlay.

Depending upon the possible future requirement of ingot tons, it is natural that the cost to be expected from a complete new layout should be looked into, in which case many of the details in this paper will still apply.

L. S. Longenecker: The analysis and comments of the charging procedure can well serve as a guide for individual shops to determine how promptly and quickly the charge materials gets into the furnaces when required. The nine items of plant equipment and layout listed for study, from "track layout" to "building and crane runways," just about covers the whole subject.

Table I shows the number of cars with storage track, etc., required for a 12- 160-ton open hearth shop. There is much other good information in this table as it shows the car movement over the charging floor and speed of charging. Apparently the car movement cycle and cars charged per 0.52 hour cycle is based on all three charging machines working on three different furnaces at one time. If the three furnaces to be charged happened to be located next to one another, then no doubt this schedule cannot hold. Also the 32 cars in front of the furnace which covers a track length of 448 ft may have to be shifted around when any furnace behind this train requires hot metal. These two items are generally responsible for a big per cent of the charging delays.

His suggestion of using layer charging boxes, more boxes per car and compress bailing of bulky scrap are excellent ways of securing faster charging and a shorter train of cars. The proposed steel plant bailer setup is of considerable interest and points up the question as to how any open hearth shop can get along without one. I assume the proposed bale size of 22 x 34 x 72 in. or 31.2 cu ft is determined by the charging box. Since this is to be a completely new baling plant, why not consider making a bale at least three times larger, namely 6 ft x 6 ft x 30 in. or 90 cu ft.

Two such bales could then be loaded on a car, without the use of any charging boxes, which will shorten the train length by one-third. The charger by means of a fork should be able to pick up a 90-cu ft bale and put it into the furnace as quickly as a 31.2 cu ft bale. The actual charging would then be sped up about three times. According to Table VII, we estimate that the

Figure 3 — The two charging openings on this plate mill reheating furnace can be opened to give a clear opening of 21 ft each.

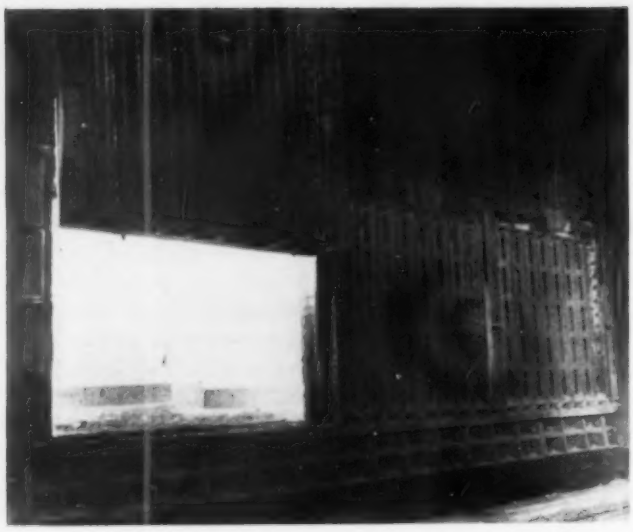


Figure 4 — The view shows one door in a raised position and exposes the refractory edge of the second door.

ingot production should be increased about 5 per cent when using 90-cu ft charging sizes.

If such baling can be done for around 40¢ per ton of scrap, it may be advisable to consider sending more of the scrap through the baler. The light scrap can be compressed and the heavier scrap simply formed into a bundle. The larger bales when loosely packed may have to be strapped so they will hold together during handling. Should it be possible to form all or most of the scrap into 90-cu ft bales then the increased ingot production of about 8 tons per heat should pretty well pay for the baling.

The open hearth furnace, to receive these 90 cu ft bales, would have to be equipped with large door openings. We believe our consecutive arrangement of doors with no buckstay or door jamb obstructions will provide the proper charging access. These are shown in Figures 3, 4, 5, and 6. Figure 3 shows an "in-and-out" type plate mill reheating furnace equipped with two twenty-one foot charging openings. Each door is 7 ft wide and the opening 5 ft high. This furnace originally had 5 doors with buckstays and front wall very similar to an open hearth furnace. The doors as shown are arranged edge to edge, and do not have any operating connection one with the other. They are individually operated and guided by means of an overhead truck which is connected to the top of the door. The flanged wheels of the truck engage the overhead rails which prevents the edges of the doors from fouling.

Figure 4 shows one door open and you can see the refractory edge of the second door. The 6-ft wide bundle could be charged through this door, and if not, the second door can be raised for more side clearance. These doors are equipped with a 9-in. thick refractory lining.

Figure 5 shows the second door being raised, note

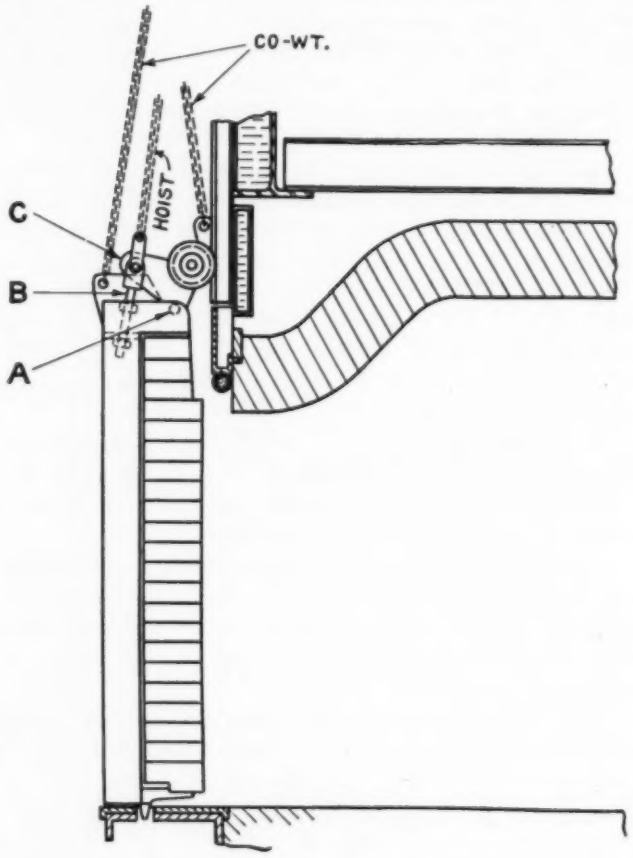
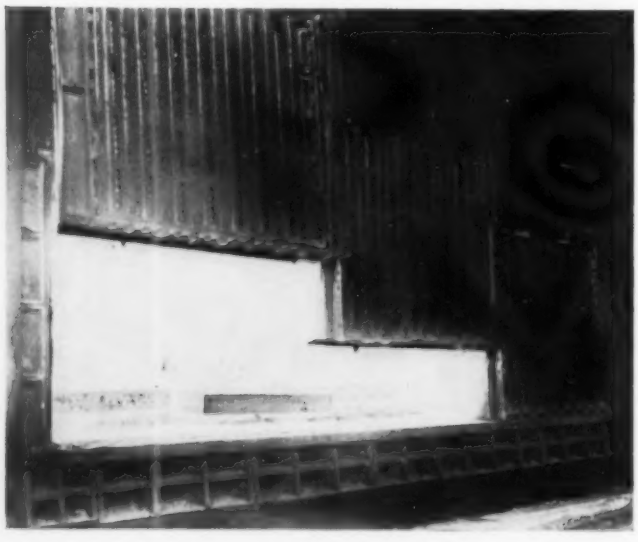


Figure 6 — Cross section through door.

Figure 5 — This view is the same as Figure 4 except that the second door is being raised.



there is no obstruction between doors. The door sill is knee braced and so far has held its alinement far better than when buckstays were used. Apparently front wall deformation is not a result of hearth pressure but rather a result of bent buckstays.

Figure 6 shows a section through the door, operating truck, roof, and supporting steel which spans the door opening. These doors use a tilting lifting motion and in the view as shown the door is in downward movement where it has contacted the door sill. As the hoist chain is still lowered, the door truck "C" pivots outward around "A" which allows the outside counterweight chain to pull the door tightly against the furnace. The bolts marked "B," attached to the door truck, engage the door with a sliding connection which

determines the amount of outward tilt. The tilting movement spaces the inside door surface free of the overhead lintel, and since the wheels on the door are the only furnace contact during operation, this door operation is 100 per cent rolling friction.

There are seven furnaces in service, each equipped with six doors as shown in Figure 3, and all have been in continuous service in excess of six years. The satisfactory operating results, the benefits in faster charging, and the less outage time for front wall repairs should put this type door setup right in line for open hearth consideration.

R. Russell Fayles: First, let me say that for the past eighteen months I have spent practically all of my time working on open hearth charging, and feel that I can make some intelligent comments on the observations that have been made so far. First, I would like to talk about the baler that has been proposed.

The gentlemen who made statements on the size of the baler and the size of bundles you would like to put in furnaces, I believe never have operated an open hearth furnace. You cannot charge unlimited amounts of this type of material. It would be my guess that no more than 15 per cent of the charge could be made of this type material.

Secondly, the larger and thicker you make the bundle the more trouble you have melting it in the furnace.

Thirdly, I do not believe you have purchased scrap from our scrap dealer friends, or have had the opportunity of observing the type of material that comes in. You get a thirty or forty-ton carload of material, but only 15 or 20 per cent of it would be applicable for bundling, and I do not know of any way to get this improved.

Fourthly, I cannot answer for all of the steel-making districts in the country, but I can answer for the Philadelphia district. We are able to purchase all of the bundles we want from the scrap dealers. We can get more than we want most of the time, so we do not see any particular object in making bundles. I can see, however, that the shops who are producing light gage material such as sheet and strip, if they will follow a planned pattern for scrap segregation in their home operation, such a baler might be feasible and practicable.

I have seen the baler at Middletown and in that particular shop it works out very well, because they seem to segregate their scrap and get it over behind the open hearth, and do an extremely good job.

That brings me down to the segregation and preparation of home scrap, probably one of the most important items in the steel plant. Too frequently the finishing departments take a rather—I guess it is a natural point of view, that they do not want to spend any money to prepare scrap for the open hearth. We went through that same situation in our own plant. We have a couple of subdivisions, one in particular, where we do a lot of shearing and punching, and work of that sort, and we received scrap with about 98 per cent holes. We agitated for a long time to have this scrap prepared at its production point, but we never succeeded until we showed management how much increase in charging box weight we could get by proper shearing and preparing of that type of scrap. Finally, through the efforts of our own organization and our industrial engineering friends, we succeeded in having this scrap prepared at the point of its production, and the results were amazing. That is something that steel mill management has to take under very serious consideration.

Another point he mentioned was timing. I do not know whether I can draw the proper simile or not, but a man, even with the best tools, does not just arrive at proper timing. Timing is a human relationship. It is like a baseball player. He may have the best ball, spikes, and a good bat and everything that goes with the game, but if he does not time it right, he does not hit the ball.

It is the same way with charging, and along those lines I can say that, for many years, the open hearth stockyard has been the "tail end of the dog." People never gave it very much consideration. They usually had some very ordinary foreman operating that particular section of the plant. My own belief is that this idea was fostered by many years of very good scrap quality, during which time very few trucks were necessary to charge a furnace, and only a few trainloads were required to be moved per ton, so that almost anybody could get away with the job. That is not the case today. It is an extremely important job, requires a man who I always like to think of as the type who would make a good chess player. He has to be able to know how to move his cars, his cranes, his engines, and so forth, around the yard to produce maximum results. We have found in our own shop that one of the greatest aids in proper timing is an installation of two-way public address communication between the stockyard and the open hearth floor.

Often lack of results comes from not knowing what the other fellow's problems are, what he is faced with, what conditions are, at a point perhaps half a mile away. So, we put in a two-way public address system in both our open hearth shops and in our open hearth stockyards. They are set up so that there are two microphone stations on each open hearth floor and three in each stockyard.

The systems are so arranged that the floor can talk to the floor or to the stockyards. That is a melter can talk to another part of the floor and call for second helpers to come down to a furnace, or call to the stockyard. Similarly, the stockyard foreman can talk exclusively to the stockyard men, crane men, conductors, and so forth, or he can converse with the open hearth floor.

After the first few weeks of singing and dancing over the microphone, we have it down to the point where they use it properly. Today, with very natural exceptions, the floor and the yard both know what is going on. The man in the yard knows if there is a tie-up on the floor, that the charger is broken down, or he has a "derail," or something of that type. The man on the floor knows that the yard is tied up, they have no shift, or a crane has broken down, or a magnet is out, or something of that type. We have found that in the proper timing of the bringing of material to the open hearth floor, nothing in our experience has equaled the two-way public address system.

The size of charging boxes was mentioned quite fre-

quently in this paper. We have done considerable experimentation with that. We found, for instance, that if you deepen a box, say 15 per cent, you are going to pick up only about an 8 or 9 per cent increase of truck weight. In other words, approximately half of the volume is recovered as weight. On the other hand, if you widen a box, you pick up about 25 per cent more than the volume you put in.

In our own shop we went from a box of 21.5 cu ft to 27½ cu ft, by widening the box about five in. We put five boxes on a truck, in place of the six which we formerly used in that service—in direct opposition to what was described in the paper. We increased our total box capacity per truck from 129 cu ft per truck up to 138 cu ft per truck, and our average truck weight went up accordingly.

We did all the things Mr. Tietig mentioned in his paper; reduced the number of trains and trucks per charge. Another important thing, by reducing the number of pans per truck, and reducing the number of trucks used, we greatly decreased the number of pans handled per heat, which I think is more important from a physical charging viewpoint than the number of trucks. After all, each time the charging machine goes in and out of the furnace, it takes an appreciable amount of time.

P. E. Haglund: There is no phase of open hearth practice where an improvement can be made to a greater advantage than in the charging of the furnaces. It should be the main interest of the entire personnel from the top executive to the third helpers.

Mr. Tietig's method of attack is certainly the most practical at present, or until such time as our orthodox charging equipment has been improved or altered. The place to look for a real improvement in the equipment end, especially, is to the swing type roof of the electric furnaces. The electrics make the open hearths look sick when it comes to charging time.

Several years ago we had an executive who unfortunately was not up to date on open hearth problems. He watched our regular practice, and the more he looked at it, the more he was convinced we were altogether wrong. Immediately he put a mechanic to work on a new type charging machine. His equipment was built on the charging machine rails, and instead of using the conventional charging box, he constructed a box about thirty feet long. The contents of this box were pushed into the furnace with a ram. This was done to save time and, to say the least, it worked well on selected scrap, but the mine-run variety gave more trouble than he could overcome.

We are still using the same equipment we started with and are anxiously waiting for something revolutionary.

R. Tietig, Jr.: I should like to make a few comments in reply to what Mr. Fayles has just said. Some of his criticisms were very well taken, but I should like to answer certain others.

In the first place, the baler I showed was designed as I expressly stated in the paper, for installation in a steel works producing a large amount of flat rolled products. It was the cost of preparation of this scrap in a baler, shown to be about forty cents a ton, against their preparation cost, which was somewhat less than $3 a ton but not less than $2 a ton, which was the influencing factor in their thinking on installing a baler. The bailer cost is not the only item, there is the building, crane, and so forth, all of which will cost in the neighborhood of $450,000. You have something to think about in that, and in a small plant it may not prove economical. Those are things you have to work out to fit the particular condition.

Regarding the timing, my particular remarks were largely pointed towards hot metal shops. I believe Mr. Fayles' is a cold metal shop, and in that case you put scrap in as fast as possible, but in a hot metal shop it is an entirely different proposition. You can get a considerable loss if you get the metal in when it is too hot, and if you do not get it in soon enough, the heat will be slow.

On the question of pans per truck, my comments, I thought, pointed out that the truck must be changed, and I think if Mr. Fayles will further analyze it, he will find if he had increased the length of his truck and kept six pans per truck, rather than cut the number of pans down, he would have made still further savings.

R. Russell Fayles: We were running on a 30-in. gage track which prohibited using larger ones. During our analysis of our charging problems, we considered a four-door furnace, but the problem presented itself. How are we going to open the taphole? You end up with a door not in front of the taphole, with a four-door furnace. Perhaps there is a simple solution to the problem, but we were not able to think of it, and for that reason we discarded the four-door idea. We did go to a large center door on three of our furnaces in our big shop. We have charging doors 6½ ft wide, clear frame opening, and somewhere around 60 in. high, and through those doors we charge our dollies, as we call them. In some other districts they call them nuggets. They are runovers from the ladle. We charge those things a good many of them, in one piece, by putting them on a peel and running them up on the floor on the first run and rolling them down in the furnace. We have charged pieces that weigh twelve or thirteen tons in a single piece.

There are two objectives in mind in doing that: One, it speeds up your charging; and, secondly, it cuts down a lot of expensive oxygen lancing of the material.

L. F. Reinartz: This paper is a well thought-out summary of open hearth charging problems. I agree with Mr. Tietig that improvement to accepted charging practice with pans and buggies offers more immediate promise than radical changes such as mass charging through removable roofs or front walls, because these new items will introduce other difficulties, some of which may be more serious than the present charging difficulties.

In Armco's new open hearth plant, our engineers are laying out overhead storage bins for burnt lime and burnt dolomite somewhat along the lines of Mr. Tietig's Figure 1.

Armco gave up the idea of using vacuum pneumatic handling of any of these materials after learning that pebble lime breaks up, particularly when loaded by means of pneumatic conveyors.

Mr. Tietig's discussion of scrap preparation indicates that in those plants, which are making large bundles,

costs could be decreased by changing from screw to hydraulically operated rams. This change would greatly simplify maintenance of such machines, and avoid some of the breakdowns which occur with other systems.

Armco expects to use charging pans of 45 cu ft capacity in its new No. 2 shop. This is practically twice the capacity of charging pans used in No. 1 open hearth shop at Middletown. Since Armco is starting from "scratch" in the new shop, we believe we can use this large box successfully without any of the limitations mentioned by Mr. Tietig when trying to use larger boxes on existing furnaces.

His comments regarding ladle cranes are about in line with the practice Armco has followed in revamping present ladle cranes in the Middletown plant. The new hot metal crane for No. 2 open hearth shop will handle hot metal charge available in one ladle, but, if and when more hot metal is available, two ladles will be required.

Mr. Tietig did not mention the use of hot metal transfer cars as a means of reducing the work of the hot metal crane on the charging floor. His thinking regarding diesel-electric locomotives versus steam locomotive power agrees with Armco's experience at Middletown, which are of diesel type. In general, Mr. Tietig's paper is in line with Armco's conclusions regarding speeding up open hearth charging, and we agree with all the points he has made.

CURRENT AISE DISTRICT SECTION MEETINGS

BIRMINGHAM SECTION

Monday, April 24, 1950 — Dinner 6:30 P.M.; Meeting 8:00 P.M.

"The Selection and Maintenance of Magnetic Brakes" by A. E. Lillquist, Supervising Engineer, Cutler-Hammer, Inc., Milwaukee, Wis.

Thomas Jefferson Hotel, Birmingham, Ala.

BUFFALO SECTION

Tuesday, April 11, 1950 — Dinner 6:30 P.M.; Meeting: 8:00 P.M.

Inspection Trip — Page-Hersey Tubes, Ltd., Welland, Ontario, Canada.

"Page-Hersey's New 16-in. Electric Weld Pipe Mill," by C. W. Morehead, Assistant General Works Manager, Page-Hersey Tubes, Ltd., Welland, Ontario, Canada.

CHICAGO SECTION

Tuesday, April 4, 1950 — Dinner 6:15 P.M.; Meeting 7:45 P.M.

"Electrical and Mechanical Maintenance of Diesel Locomotive Equipment," by Paul H. Verd, Superintendent, Motive Power and Equipment, Elgin, Joliet and Eastern Railway Co., Joliet, Ill.

Phil Smidt's Restaurant, 1205 North Calumet Ave., Hammond, Ind.

CLEVELAND SECTION

Monday, April 17, 1950.

Cleveland Section will meet with Pittsburgh Section.

DETROIT SECTION

Tuesday, April 11, 1950 — Dinner 6:30 P.M.; Meeting 8:00 P.M.

ROLLING MILL SYMPOSIUM
Led by Paul Carnahan, Production Manager, Great Lakes Steel Corp.

"New Slab Shear at Rotary Electric Steel Co.," by Chas. Hammond, Superintendent Rolling Mills, Rotary Electric Steel Co.

"Cold Rolling — Carbon Steel," by N. Rothenthaler, Manager, Steel Mill Scheduling Department, Ford Motor Co.

"Instrumentation for Improved Rolling Temperature Control," Leeds and Northrup Co.

Horace Rackham Educational Memorial, 100 Farnsworth Ave., Detroit, Mich.

PHILADELPHIA SECTION

Saturday, April 1, 1950 — Dinner 6:00 P.M.; Meeting 7:00 P.M.

"Conditioning of Finished Surfaces on Large Housings in Place," by E. A. Berry, Superintendent of Machine and Forge Division of Centralized Maintenance, Lukens Steel Co., Coatesville, Pa.

"Time Saving Methods in Rebuilding of Blast Furnaces," by T. A. Lewis, Superintendent, Service Division, Bethlehem Steel Co., Bethlehem, Pa.

"Emergency Repairs, and Rebuilding of Open Hearth Hot Metal Charging Crane," by A. D. Howry, Assistant Superintendent of Maintenance, Alan Wood Steel Co., Conshohocken, Pa.

"Repairs to Heavy Castings," by G. O. Van Artsdalen, Superintendent of Maintenance, Henry Disston & Sons, Inc., Philadelphia, Pa.

"The Maintenance of Hydraulic Valves," by John H. Dotter, General Millwright Foreman, Plate Mills, Bethlehem Steel Co., Sparrows Point, Md.

Engineers' Club, 1317 Spruce St., Philadelphia, Pa.

PITTSBURGH SECTION

Monday, April 17, 1950 — Dinner 6:00 P.M.; Meeting 7:00 P.M.

INSPECTION TRIP through Beaver Falls plant of Babcock & Wilcox Tube Co. Buses leave Brodhead Hotel, Beaver Falls, Pa. at 1:00 P.M.

"Some Aspects of Continuous Casting," by Isaac Harter, Jr., Babcock & Wilcox Tube Co., Beaver Falls, Pa.

Brodhead Hotel, Beaver Falls, Pa.

TRAINING OF STEEL PLANT LUBRICATION PERSONNEL

By W. M. SCHUCK
Lubrication Engineer
Armco Steel Corp.
Middletown, Ohio

. . . . lubrication personnel, far from being unskilled, require complete, thorough and repetitive training . . . .

▲ THE average steel producing and steel processing plant of today represents an investment of several hundred millions of dollars. Many millions of this sum is capital investment in the plant equipment with which the steel is processed, and many more millions are represented in the raw materials from which this basic product steel in any of its many forms is made. Still more millions are expended each year for labor, maintenance, and innumerable other service items. One small part of this steel producing cost, and a rather small part indeed when compared with the other monies that must be spent to successfully operate a steel plant, is the cost of the lubricants used to keep this basic industry running.

An excellent parallel of this condition can be made by referring to a new automobile. This new car represents an expenditure of approximately $2803.00 (for 1949 models) of which $2800.00 is the cost of the car itself, while the $3.00 additional was for the lubrication necessary to make this method of transportation operable. Without that $3.00 lubricant investment correctly applied, the entire $2800.00 car is inoperable or worthless as a means of travel.

This is exactly the condition that a steel plant would be in if a similar lack of lubrication be effected in the plant as in the automobile. Pursuing this analogy still further, the $3.00 of lubrication for the car must include as part of its purchase the correct application of that oil and grease, or again the entire $2800.00 investment is rendered useless. Definitely, this condition also applies to the average steel producing plant. Admittedly, lubricants and the application of lubricants to the equipment of the average steel plant is the "mighty midget" that allows all of this gigantic mill investment to operate and thus produce a product that can be sold. Further, the use of this "midget" requires some "know-how" not only in the original purchase of the products to be used, but in the method, the manner, and the control with which these materials are applied.

With this premise agreed upon, the actual equipment of an average steel producing and processing plant can now be investigated to ascertain its bearing on this problem of lubricant buying and application "know-how." The average steel mill was not constructed as an entire integrated unit but is the result of long years of expansion. This expansion was caused by larger market demands for products as well as the need to remain on a competitive cost basis with other average steel mills. As a result of these factors, the average mill contains equipment dating from its earliest days as well as other mills, furnaces and processing machinery that are modern and new in every regard. This condition, if examined from a lubricant application standpoint, has a definite bearing upon the lubricants purchased and the "know-how" of the personnel connected with the average steel plant. Equipment diversified by time requires lubricants that have also been diversified or improved through the years.

Exploring this equipment and lubricant diversification still further, and entering the phase of application "know-how," a major point of weakness in the "mighty midget" becomes apparent. This weakness is the very obvious fallacy of depending upon inherited "know-how" in training the personnel responsible for lubrication application. Just as some of the equipment in the average steel plant dates back to the inception of that plant, so are the lubrication application practices dated back to that early day. As a 1949 automobile required lubrication from the moment it was driven the first mile, so has this average mill required lubricant application from the time it first produced a pound of steel. Naturally, to meet this lubrication demand the original personnel in the mill formulated and put into practice methods of lubricant application to meet the requirements of that early equipment. The design of the old style mill equipment did not require too much "know-how" to lubricate it adequately, rather the emphasis lay on frequency of application. Then, through the years as the original oilers moved on to other and better positions they trained the new incoming men by word of mouth and example in the manner they had found adequate for the original equipment. This method of training was fine and probably needed no other aid so long as the original machinery remained in use, but as newer mills and processing machinery replaced the older outdated units, newer, more modern lubricant application techniques were required. Usually, however, these newer techniques or application "know-hows" were not available. Certainly, the type of available job training for the newer oilers could not

supply the information. It is granted that some additional knowledge drifted in to the lubricators by devious paths, but certainly that knowledge or information was at best sketchy and only partially complete. With these training methods, there was only one course to follow, that is, as the years passed and as more and more modern equipment supplanted the old original mills and processing lines, the sum total of adequate true knowledge of lubrication requirements and lubrication application became less and less. Obviously, this weakness of the "mighty midget" can and has in the past caused uncounted troubles in the average steel plant.

To continue this investigation of the "mighty mite" and the average steel plant, it is necessary now to consider the "oiler" himself and his position or standing among the other employees of the plant. Again, the early history and operation of the mill have a direct bearing upon the problem. The early original units required very little knowledge to apply lubrication to them. Rather it required mainly a pair of very dirty overalls, a large spout oil can and almost continuous walking and pouring on the part of the oiler. Naturally, a job having these requirements fell to the lot of the youngest man in the maintenance crew. Generally, this condition or position of the oiler with respect to his fellow workers has not changed from those early days even in the most modern mills. Obviously, there are many practical as well as psychological disadvantages attributable to this unfortunate position. First, it is axiomatic that more people move into and out of an organization in the lower levels of employment than in the higher or supervisory bracket levels. Thus, the labor turnover in the lubricator or oiler level of employment is as high as in any job class of employees. This condition of rapid labor turnover produces a continuous and ever increasing problem. Not only must a large number of oilers be trained every year, but with the old style contact and show by example method of training, their knowledge of the responsibility and importance of their job is soon lost. While this high labor turnover has the disadvantages mentioned, this very condition can be turned to an advantage if proper, modern training is given these men. Based upon a long term policy, the proper training of the oiler group in correct lubrication practices and methods must eventually permeate the entire maintenance organization as some of these men move up to take better maintenance positions. It should be stated, however, that in view of the added responsibility and need of correct lubrication today, the position of the so-called oiler no longer belongs at the bottom of the maintenance staff but this position should now compare to, at least, the lowest journeyman mechanic. Obviously to produce in a man a sense of pride in his work, there must be a financial as well as a personal sense of advancement or accomplishment.

Thus far in this paper we have simply investigated the problem of steel plant lubrication as it existed to a greater or lesser extent at the beginning of management's consideration of this problem. With management cognizant of the problem as it exists and the need to correct these faults, it then becomes imperative to formulate a program or policy to eliminate these conditions. In adopting this policy and placing it in use, obviously the most important phases of the program should be accomplished first with the refinement phases held in abeyance or retarded so that the greatest return can be realized in the shortest period. The writer would like, at this time, to present the policy program as adopted by his company to fill this need for a constructive plan on which to build a successful lubrication organization. Briefly, this policy consists of nine points or goals listed in sequence of their importance or urgency that comprise the entire lubrication needs of our steel plants as seen from a long range viewpoint.

LUBRICATION POLICY

1. *Training*
   This is the most important phase of the program, and upon its success depends the entire future of the policy as such. Complete, correct lubrication training is essential before any control of the use of lubricants, application to equipment, or preventive maintenance through lubrication can be even attempted.
   a. Lubrication classes, designed to effect such training, should be held periodically. It is thought that two general classes each year will be sufficient for the training of new personnel and for "refresher" training.
   b. All newly employed maintenance personnel, apprentices, and present maintenance personnel of all classifications to and including the "oilers" should be given lubrication training as quickly as conditions and adequate groups are available. New supervision within the operating divisions should, also, be extended an invitation to avail themselves of this training.
   c. Men closely connected with lubrication, such as inspectors and oilers, should be included in subsequent classes for refresher work and as aids to the instructor in training new personnel within the class.
2. *Plant Lubrication Survey*
   A complete survey within the various plants should be made describing the type of equipment, method of application, and grade and name of the lubricant presently employed.
   a. The survey should be complete in its coverage of all the equipment within the plant, and as new equipment is added or changes in present equipment, changes in method of application, or changes in the lubricant itself are made, the survey should be so modified.
   b. Products found by the survey and investigation to be duplicates of other lubricants employed in the division should be eliminated.
   c. General application such as ring-oiled motor bearings or waste packed type crane bearings, should be standardized throughout the plant in regard to the lubricant employed as well as the method of application and frequency of service.
   d. Simplification of the number and grade of lubricants used within the plant should aid in the actual application, encourage volume purchasing, and conserve valuable storeroom and maintenance space.
3. *Periodic Testing of Major Closed Circulating Oil Systems*

As a preventive maintenance tool, this phase is the most important one of all. An actual knowledge of the condition of the medium protecting "key" units of equipment will forestall major and costly repairs.

a. Testing should be on a monthly basis and the results so tabulated as to give a complete analysis at all times of the lubricant concerned.
b. Complete reporting of test results should be made at stated periods to all concerned so that intelligent repair programs and adequate preventive maintenance measures can be planned.

4. *Consumption Control Report*
This report should include the quantity of each type and grade of lubricant used within the plant. It should be divided by departments and compiled on a monthly basis.

a. This report will act as a control on the consumption within any specified department. Any major variance in consumption should be investigated as a possible indication of equipment damages or equipment change.
b. A more correct apportioning among the various lubricant suppliers can be accomplished by this means.
c. These data will afford comparison material when testing new products.

5. *Simplification Within Division Departments*
The elimination of excess grades and types of lubricants should be accomplished within a department of the plant as well as within the plant as a whole.

a. Overgrading on some applications can be very economical where a department can eliminate one or a number of lubricants by so doing.
b. Relatively few departmental lubricants directly ease the oiler's application problems and in turn aid the lubrication of the equipment concerned.

6. *Testing of New Products*
This phase should not be attempted to any large degree until all above mentioned phases are operating satisfactorily.

a. The allocation of all testing should be made by the chief lubrication engineer. This will eliminate duplicate testing by the various plants and allow a centralized agency to place the testing procedures where the most severe conditions are to be found.
b. Tested products should be given company-wide approval or disapproval by the chief lubrication engineer before the plants standardize on the use of such products.

7. *Engineering Investigation of New Equipment*
The lubrication engineer within each plant should be consulted and coordinated with before the planning or purchasing of any piece of new equipment.

a. Centralized lubrication systems on new equipment should conform in make and type with the plant policy on such equipment.
b. Wherever possible, bearings, gearings, and cylinders of all new equipment should be designed to fit present plant lubricants and plant methods of application.
c. Present plant lubrication practice as it affects new equipment should be approved by the equipment manufacturer prior to the actual purchase.

8. *Lubrication Practices*
The methods of lubricant application, the time intervals between applications and the personnel entrusted with lubricating tasks should be standardized as far as practical and consistent with good lubrication theories.

a. Overlubrication is considered to be a fault that stems from poor control of lubrication time intervals and a definite company-wide policy on general types of application must be developed.
b. Bookkeeping or paper control of all lubrication is considered a necessity if the steel mill is to be assured of correct lubricant applications. The type of control finally adopted should be, insofar as possible, standard throughout all plants.
c. Where possible the number of personnel entrusted with lubrication tasks should be held to an absolute minimum. Eventual lubrication of the entire plant by a small group entirely divorced from other duties is a goal to be achieved as the best possible method of control.

9. *Codification of Lubricants*
A standard company-wide system for coding lubricants in use throughout the divisions should be considered and formulated. Control and application by a code system will eliminate, to a great degree, the often misguided preferences for definite brand name products presently in effect.

a. Coding will allow more complete standardization of lubricants within the plants. It will, also, simplify to a large extent the ordering of lubricants from plant stores.
b. A coding system will allow field tests to be conducted on a more impersonal basis by eliminating any personal prejudice that brand names might engender.

Obviously, based upon urgency and importance the writer's company considers adequate training to be the most vital phase of their lubrication program, and it is with the accomplishment of this phase that the remainder of this paper will deal. In thinking about this problem, the first consideration naturally was, who should receive this type of training. Primarily, the department of a plant performing the great majority of the lubrication duties was the maintenance group, so obviously that section should receive the bulk emphasis. Second, among the maintenance men, the oilers were concerned most exclusively with this problem, while the journeymen, mechanical and electrical, though not physically responsible for any but a small percentage of the lubrication tasks were responsible for the oilers themselves. Third, the maintenance inspectors, whose duties are the continual inspection and reporting of equipment condition both electrical and mechanical, performed no lubrication work but were vitally interested in the effects of good and bad application practices. Fourth, if this program toward complete adequate lubrication were to remain a continuing active force, then new personnel and apprentices should be correctly trained and instructed in the early days of their company service to replace and eliminate the older, faulty, word-of-mouth, partial knowledge "know-how" method of training. Lastly, and by no means least, the maintenance supervisory group, foremen and gen-

eral foremen, who are held responsible for the actions and duties of all these aforementioned groups must be made cognizant of the needs and requirements of modern lubrication. They must also be informed and therefore understanding of the reason for, and causes of the lubrication changes that would accrue as the result of these training classes. These personnel groups were essential attendants to the training program, but in addition it was felt that several other groups should be given this training opportunity as time and classroom space permitted. This training could afford members of the engineering staff the opportunity to refresh their knowledge of lubricant design for new equipment as seen from a maintenance standpoint. It was also felt that newly appointed supervisory personnel of the operating departments would better understand the definite need for maintenance control and lubrication of their equipment if they understood the basic theory and action of oils and greases. From all these groupings should come the trainees for the proposed lubrication classes.

Because of this wide spread of groups interested in lubrication, the mechanics of the training program were also investigated thoroughly. The amount and degree of training thought necessary made it advisable to estimate the total required classroom hours for the complete course at forty hours of instruction. This figure may appear excessive in the case of oilers but not so when supervisors, maintenance inspectors, and engineering department personnel are considered. The possibility of conducting these classes for eight hours a day and completing the course in one week of five days was debated, but the definite hardships of requiring men accustomed to the physical activity and motion of steel mill duties to remain in class for these extended periods precluded such a class schedule. Finally, the decision was made to hold four hour classes from 8 a.m. until noon each day, and to have the complete course extended over two five day week periods.

The question of class size was also considered, and it was felt that a maximum group number of fifteen should be the limit in this direction. This maximum was thought to be the largest group possible which would still enable the instructor to effect personal contact with each of the class members.

Still another phase of the class mechanics came up for review and that was the class personnel mixture. In order to make each student feel at ease and free to ask any question, no matter how foolish, it was decided that general maintenance foremen or superintendents, for instance, would not be included in the same class with oilers or mechanical and electrical repairmen. While this consideration obviously increased the difficulty of arranging these classes, it was more than justified subsequently in the complete interest evidenced by all members of all classes. As a final thought, it was decided to have the actual teaching performed by a two-man team.

One of the two instructors would read a section of the training manual, while the other member of the training team made notes and aided the class as far as possible in following the reading. After the reading of a section of the manual, it was then the duty of the second teacher to elaborate upon the text and clear up any question the class might raise. The text itself also includes within its pages a complete set of questions and these were then asked of the class. This method as outlined was generally the procedure and mechanics adopted in all of the company divisions to effect this needed lubrication training. The results are, of course, not all available because this type of training is intended to be a continuous project. It can be stated, however, that all of the classes held to this date have been received with a great show of interest, and the results, as indicated by better and more knowledgeable lubrication in the mills, have been more than encouraging. Automatically, the man, who knows what he is doing and why he is doing it, is a better workman no matter how lowly or simple the task.

In order to obtain and hold the interest of the members of this type of class in lubrication, it is necessary to generally combine the theoretical phases of the course with as many practical aspects as possible. Particular effort must be made to have the practical problems or phases coincide with the problems or concerns of the particular plant employing the class personnel. If these plant problems are tied in with the particular theoretical discussion, let us say, of viscosity and viscosity determination or with extreme pressure theories or oxidation tests then the benefit is twofold. First, the theory and theoretical reasons behind the selection of a particular lubricant for a particular application are strongly impressed upon the class; and second, a better understanding of what to watch and guard against from a lubrication standpoint on a particular key equipment unit is planted in the minds of the very personnel charged with the preventive maintenance and care of that key unit. The training course and program should be so adjusted throughout the series of classes that each practical problem is used to explain a theoretical phase of the text and no theoretical section should be completed without explaining its practical use. This coordination should be strictly adhered to, even if, in searching for a practical aspect, the problems of other divisions within the company must be utilized to illustrate a point.

It might be well at this point to outline the training manual utilized by the speaker's company in conducting these training classes. The manual is liberally illustrated with line sketches wherever a diagrammatic picture can aid in simplifying the text material. A great amount of the text is the result of compiling current literature from many sources and eliminating from these source materials all extraneous matter not directly concerned with steel mill applications. The manual attempts, in a simple non-technical language, to explain the physical properties of oils and greases and the common or usual methods utilized to apply them.

In the first chapter a brief history of the use of petroleum is supplemented with a discussion of crude oil sources; the hydrocarbon structure of paraffinic and napthenic oils; a short description of refining and ending with the complete specification of a transformer oil. This last item in chapter one, the transformer oil specification, was placed there purposely to stimulate curiosity in the physical tests of oils and greases that comprise chapter two.

These physical tests are simply the A.S.T.M. stand-

ard tests for determining A.P.I. gravity, flash and fire, color, viscosity, viscosity index, SAE numbers, cloud and pour points, neutralization number, steam emulsion number, precipitation number, ash content, carbon residue, sulphur content, corrosion tests (both steel and copper) oxidation tests, penetration, dropping point, analysis of grease, extreme pressure testing machines and dielectric strength. In each of these A.S.T.M. tests, the test method, test equipment and test results are explained and then the ultimate use or need for such a test illustrated in terms of plant equipment. In general, the discussion of the use of a particular test as applied to definite operating equipment informs the teaching team whether the theory is understood by the trainees or if additional explanation and instruction is required to complete that phase of the test material. At the conclusion of the work in chapter two, it was found to be very effective to return to the transformer oil specifications for a second time. Usually, the surprise of the trainees at how much more intelligently they now read and understood this specification was a clear indication of the value of this chapter to them.

Chapter three of the manual concerns itself with the requirements of industrial oils, an explanation of boundary and full fluid lubrication, the theory of extreme pressure lubricants, explanation of the hydrodynamic theory for sleeve bearings and a brief discussion of the new synthetic lubricants with their place in steel mill lubrication.

Chapter four deals with grease types their uses and limitations. Following this discussion a general lubrication survey of an average mill is explained and again the reasons for certain oil and grease selections re-emphasized.

Chapter five and chapter six discuss all types of application methods from the simple ring oiled bearing to the centralized grease systems generally found in use on all large key mill equipment. That concludes the actual text material, but it has been the usual class history at this point that the last four hours of the class are required to review some or most of the text in light of local plant equipment. Men who have previously considered the "oiler" and his tasks of very minor importance, have, after reaching this late date in the course, become very interested in any and all phases of the problem. Discussion classes could be continued almost indefinitely with these men who are now cognizant of the true size of this "mighty midget" adequate plant lubrication.

DISCUSSION

PRESENTED BY

WALTER DOUGLASS, Lubrication Engineer, Lukens Steel Co., Coatesville, Pa.

KARL ARNOLD, Lubrication Engineer, National Tube Co., Ellwood City, Pa.

ROBERT A. KRAUS, General Mechanical Foreman, Republic Steel Corp., Chicago, Ill.

F. C. SCHOEN, Chief Engineer, Alan Wood Steel Co., Conshohocken, Pa.

DONALD E. WHITEHEAD, Lubrication Engineer, Crucible Steel Co., Pittsburgh, Pa.

W. M. SCHUCK, Lubrication Engineer, Armco Steel Corp., Middletown, Ohio

Walter Douglass: There are a number of elements in training that we feel are so important that it is impossible to place too much emphasis upon them. In our plant, we have found that the type of plant survey that Mr. Schuck described to us was very useful in setting up guide charts for our lubrication men to follow. These charts have taken from the oilers any responsibility for the type of lubricant used and for the frequency of application. Consequently, the oilers now plan their work more systematically, and they are quite conscientious in the performance of their duties.

It is, we agree, important that the oiler should receive pay that is comparable to the other mechanics with whom he works. With the advent of centralized lubrication systems, the oiler has to be a mechanic to fill his job. One other item that should not be overlooked is the human side of foremanship. In addition to the technical side, we feel that a genuine interest in the pet peeves and the pet projects of even the lowest oiler goes a long way toward reducing our labor turnover.

As Mr. Schuck has said, it is important to follow through on training classes; retraining again and again is an important part of maintaining an alert crew of men.

We like to think that machine history records are valuable in giving us a sign-post by which we can tell whether or not retraining is needed in a particular area.

A training program, besides having engineering meaning, also has to have some meaning that reflects in the individual workman's pocketbook and upon his chances for advancement. I would like to ask Mr. Schuck if he can give us some yardstick by which we can classify our trainees as they go through the training periods, as to just how to compare their abilities, one with the other?

Karl Arnold: It is no secret that to obtain proper lubrication, trained men are required to do the work, and that associated personnel must understand the functions of lubrication.

Undoubtedly Mr. Schuck's program is a very good one and very inclusive. The selection of lubricating personnel is not an easy one and it should be given thought. The oiler should be, naturally, selected from the mechanical maintenance department for he should be mechanically inclined, he should be capable of learning new things, he should be able to analyze operating conditions and he should be capable of understanding machinery. These qualifications require that the oiler should be paid a rate equivalent to his importance, for if he does not do his job, the machinery will not do its job.

That the oiler be capable of understanding machinery is of great importance. The oiler should be taught about the differences of bearings, such as plain bear-

ings, roller and ball bearings and their differences in operation and consequent lubrication. It is not sufficient that the oiler know only the lubrication required of a grease fitting or oil cup, he should also know what that lubricant is to do inside that bearing and bearing housing. This is also applicable to gears; whether the gears are enclosed or open, whether they operate slowly or rapidly, and the nature of the gear loads. He should be taught to have an understanding of various bearing materials and journal materials, and their relationship to each other when in combination.

It is particularly important that the oiler understand the particular machinery he is taking care of—this applies to automatically lubricated equipment as well as hand lubricated machinery. The oilers first days on the job should be spent in company with the lubrication engineer or maintenance foreman in going over the various equipment he is to lubricate. He should have pointed out to him, and very thoroughly explained the various working parts and their operating conditions; then he will more adequately associate the lubricating schedule with the needs of the particular machine.

The training of lubrication men for steel mills would necessarily be on the practical side. Most of them are not interested in deep theory and that is particularly the job of the lubrication engineer. They should be taught the various types and grades of oils and greases and their relationship to the various working parts of the machinery, such as extreme pressure lubricants for heavily loaded gears or bearings, etc. It is important that oilers understand the practical reasons for the use of various lubricants in the different parts of the equipment, for they have an almost continuous check on the performance of the lubricant while it is working.

The oilers should be taught a good working knowledge of the operation of the different types of lubrication equipment in use in the plant. Part of their training time should be spent in becoming thoroughly familiar with the automatic systems, portable grease guns and hand grease guns. In view of the fact that lubricating equipment operates in no mysterious manner, it is obviously important that oilers understand how this equipment operates. They should have it explained to them, and they should become thoroughly familiar with this equipment so as to operate it correctly and make minor adjustments and repairs.

Included in the training programs, in addition to oilers, should be operating foremen and their supervisors. They should be thoroughly instructed as to the production benefits to be realized from regular and adequate lubrication to operating equipment; this would be of major interest to them in the form of peak operating efficiency of the machines, considerably less downtime and uninterrupted production schedules.

Robert A. Kraus: During the war years, we had quite a problem with oilers—here one month, gone the next. That problem has now ended to a considerable extent and we can now profitably train men with a greater feeling of confidence that they will be with us for an extended period of time.

Experience has shown that in practically all cases this employment period is sufficient to warrant that expenditures be made to adequately train these personnel. The return, of course, is obvious. Your oiler is far more valuable than his apparent position in the maintenance force. He is the one man in this force whose procedure requires him to visit each piece of equipment on a regular schedule. If this man is properly trained, he can catch potential breakdowns while they are still small repair jobs, thus saving mill delay time as well as unnecessary secondary damage expense. We hope that our millwrights make similar inspections but again experience has shown that other activities frequently take precedence and the inspection is omitted.

The training program has considerable value in extracting the full worth out of automatic lubrication systems. As long as a lubrication system functions correctly, the system is a valuable asset, but if the system becomes inoperative or is damaged, the unit will revert to a liability because seldom does the personnel concerned with maintenance make an effort to hand-lubricate machinery to which an automatic system is attached. Prompt attention to the lubrication system will, of course, rectify the difficulty and it is in this direction that the educational program is directed.

Formerly few people in the maintenance force were sufficiently familiar with system repairs to do an adequate job of diagnosing and repairing the difficulty, but with adequate training these conditions can be remedied.

I would like to know for what period of time this program has been going on, and if results are already apparent in, say, reduced maintenance costs? Secondly, whose function was it to prepare the manual that was mentioned in the paper?

F. C. Schoen: I would, however, be interested in Mr. Schuck's comments on lubrication organization. Where does the lubrication engineer fit into the picture in the average plant? Are the oilers going to come under the lubrication engineer or are they going to come under the division maintenance foreman? If they do come under the latter, are we working under a divided responsibility that is going to get us into trouble?

In line with that same thing, the lubrication engineer is usually responsible over several divisions of the plant. I have a feeling that his standing should be, at least, on a par with any of the maintenance superintendents, so that he will have a chance to get better cooperation. I would like to have your comments on that.

Donald E. Whitehead: In observing lubrication practices in many steel plants it will be found that the "oiler," as we have known him, still functions in the older mill units wielding his long spouted oil can. However, in the modern mills where continuous automatic lubrication systems and devices prevail, millwrights and machinists frequently function as lubrication attendants. In addition, mill cranes are lubricated by crane operators, pumping station equipment by pump operators, etc. In this manner, an upgrading of the oilers job has taken place and among these ranks job turnover occurs at a reduced rate.

In the very large steel works it may be more practical and advantageous to direct specialized lubrication training than to attempt a general lubrication training program. Many of these works have regular job training programs in process where lubrication becomes an important chapter in the job training program. This training is supplemented by the perpetual efforts of an

assistant lubrication engineer or lubrication supervisor, directed toward coaching and demonstrating lubrication to the man on his job where demonstrations and discussions are most effective in creating personal interest and in encouraging the worker.

In a large steel works the training cost for instructors' time will be less, as well as lost job time on the workers part, when the specialized and individual training method is applied.

Mr. Schuck discussed coding of lubricant containers in his paper. Barrel head coding can be helpful in properly identifying lubricants by mill personnel provided the coding is held in simple form; otherwise I have found such coding to be more complicated than brand names. If a practical descriptive coding such as calling cup grease as cup grease is used, the cost in effort and time required to continually identify the coding system will be negligible. A self-explanatory coding system is readily assimilated.

W. M. Schuck: Mr. Douglass asked how to evaluate the ability of the trainee, I cannot say. We have, in one of our divisions, a small group of especially trained men who do nothing but lubrication work. The entire lubrication responsibility for that division is within their hands. In this plant we make it a practice to work two-man teams. New men coming into this department are placed with an older trained man for a minimum of three months. To a large degree the decision as to whether a new man will stay in that particular section or not depends upon the older man's evaluation at the end of the three-month indoctrination period. He is either capable of doing independent lubrication work or he is not; that is as far as we have gone along this line.

In answer to Mr. Kraus' question as to how long we have had a training program—a little over two years. This training has been accomplished in all the divisions under the supervision of the lubrication advisor within that division. The initial program was inaugurated by my predecessor. He trained all of the lubrication advisors who had been selected by the various divisions in an initial training course. That course was naturally much more intensified than the training we are presently giving in the divisions.

Whose function was it to prepare the manual? That was the chief lubrication engineer's task, my predecessor. In my opinion, he did an excellent job. The manual has been changed somewhat to meet the different conditions, as we found them to exist, under the actual training program.

In answer to Mr. Schoen's question as to where the lubrication engineer belongs in the plant personnel picture; in our particular case that is still under advisement. However, in my opinion, he very definitely belongs in the maintenance organization. He should rank somewhere in the range of a general foreman, under the superintendent of maintenance, and acting in the capacity of a staff man for the maintenance superintendent. We have a lubrication advisor in each division placed within the maintenance organization in this manner. In this capacity he also acts as liasion between the maintenance department and the engineering group.

So far as the need for coding is concerned, it is more to inhibit the feeling for old lubricants rather than against new ones.

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Rotary Electric Steel Co.

J. W. Johnson
Tennessee Coal, Iron and Railroad Co.

1. "Billet Size Ingot Practice"
   Roy W. Scholl, Assistant to the Executive Vice President
   Connors Steel Co.

2. "Modern Blooming Mill Practices"
   D. W. Lloyd, General Superintendent
   Brier Hill Works
   Youngstown Sheet and Tube Co.

3. "Manufacture of Electric Fusion Welded Pipe"
   J. H. Middleton, Chief Metallurgist, Southern District
   Republic Steel Corp.

9:15 a.m. — Technical Session — Colonial Room

Co-Chairmen:
E. A. Hawk
Tennessee Coal, Iron and Railroad Co.

Walter Nielsen
Sloss-Sheffield Steel and Iron Co.

1. "Underground Coal Gasification at Gorgas"
   Milton H. Fies, Consulting Engineer

2. "Technical Aspects of Northern and Southern Blast Furnace Practice"
   C. G. Hogberg, Assistant to Chairman of Blast Furnace Committee
   United States Steel Corp. of Delaware

3. "Some Aspects of Annealing Atmospheres Used in the United States for Tinplate Strip"
   James R. Trimble, Assistant Manager
   Department of Metallurgy, Inspection and Research
   and
   J. Ernest Hill, Metallurgical Engineer, Sheet and Tin Mills
   Tennessee Coal, Iron and Railroad Co.

1:30 p.m. — Buses leave the Tutwiler Hotel for Inspection Trip to Connors Steel Co.

7:00 p.m. — Dinner — Terrace Room

Speaker: Clayton Rand, Gulfport, Miss.

MILTON H. FIES

C. G. HOGBERG

J. ERNEST HILL

A. F. EISEL

TUESDAY, APRIL 4, 1950

9:00 a.m. — Rolling Mill Session — Terrace Room

Co-Chairmen:
J. N. Imel
Jones and Laughlin Steel Corp.

R. M. Lang
Atlantic Steel Co.

1. "Recent Developments in Blooming, Bar and Billet Mills"
   A. F. Eisel, Chief Roll Designer
   United Engineering and Foundry Co.
2. "Roller Guides"
   Clark Lambert, Superintendent of Merchant Mills, Campbell Works
   Youngstown Sheet and Tube Co.
3. "19-Stand Rod Mill of Keystone Steel and Wire Co."
   Wm. Herman, Superintendent, Rolling Mills
   Keystone Steel & Wire Co.

CLARK LAMBER

9:00 a.m. — Technical Session — Colonial Room

Co-Chairmen:
Eric Anderson
Bethlehem Steel Co.

Alex Henry
Tennessee Coal, Iron and Railroad Co.

1. "The Blooming Mill — Steel Industry's Iron Horse"
   Ralph H. Wright, Steel Mill and Metal Working Section
   Westinghouse Electric Corp.
2. "Developments in the Design of D-C Motors and Generators for Rolling Mills"
   B. H. Caldwell, Jr., Section Engineer, Large D-c Motors and Generators
   General Electric Co.
3. "Continuous Cascade Pickling"
   W. H. Stuck, Metallurgical Investigator
   Jones and Laughlin Steel Corp.
   and
   J. H. Abrams, Technical Representative
   American Chemical Paint Co.

WM. HERMAN

1:00 p.m. — Buses leave the Tutwiler Hotel for Inspection Trip to strip mills, and tin mill at Fairfield Works, Tennessee Coal, Iron and Railroad Co.

RALPH H. WRIGHT

B. H. CALDWELL, JR.

W. H. STUCK

J. H. ABRAMS

Inspection Trips

CONNORS STEEL CO.

BIRMINGHAM, ALABAMA

MONDAY, APRIL 3, 1950

1:30 P. M.

Buses leave the Tutwiler Hotel for an inspection trip to the Connors Steel Co.

This plant features a number of unusual practices which will be of particular interest to rolling mill men.

▲

TENNESSEE COAL, IRON AND RAILROAD CO.

FAIRFIELD WORKS

FAIRFIELD, ALABAMA

TUESDAY, APRIL 4, 1950

1:00 P. M.

Buses leave Tutwiler Hotel for Inspection Trip through the strip and tin mill at the Fairfield Works of the Tennessee Coal, Iron and Railroad Co.

This plant has incorporated many new developments in equipment which has been installed since the war and in modernization of their older equipment. These changes are of interest to the industry.

▲

Special Inspection Trips

Arrangements have been made by which special trips may be made to a number of plants in the Birmingham area. Some of these trips undoubtedly will be of interest to the operators attending the Spring Conference. Among the plants who have indicated their willingness to have visitors are the Atlantic Steel Co., Atlanta, Ga.; Woodward Iron Co., Woodward, Ala.; and the American Cast Iron Pipe Co., Birmingham, Ala. Arrangements for these trips and perhaps others can be made for April 5th or 6th. For further details check in at the registration desk.

ABSTRACTS OF TECHNICAL PAPERS

FOR

Annual Spring Conference

April 3-4, 1950

Birmingham, Alabama

BILLET SIZE INGOT PRACTICE

By ROY W. SCHOLL
Assistant to the Executive Vice President
Connors Steel Co.
Birmingham, Ala.

▲ THE manufacture of steel products from billet-size ingots attained increased importance during World War II due to the heavy demand on the steel industry as a whole. Steel making practice, which employs the use of small size ingots, is rather unique and lends itself well to small tonnage heats. In most cases the small billet-size ingot is rolled from the initial heating to the finished product without intermediate breakdown or rerolling.

Connors Steel Co. introduced the billet-size ingot practice in 1939. Its steel producing facilities consist of two electric furnaces, one having a rated capacity of three net tons per hour and the other having a rated capacity of 4½ tons per hour. These furnaces are charged with approximately 7 and 12-ton heats, respectively. Both single and double slag basic practice is employed and the particular size ingot that is to be used is determined by the type of finished product that is to be produced. The electric furnaces are top charged with scrap so selected as to control the composition of the meltdown for efficient time cycle of refining. The charge melts down rapidly at the beginning and when the electrodes are bored through the scrap, the electrodes are then raised and the roof is lifted and the prepared scrap for this particular use is charged into the holes left by the electrodes. This protects the bottom of the furnace. The roof is then swung into place and the melting proceeds.

The pouring of the billet-size ingot is performed in the conventional manner with some slight deviation from large ingot practice, such deviations being the elimination of the pouring platform and the insertion of hooks or pins into the top of the ingot to facilitate subsequent stripping. Hot tops are frequently used. The technique in handling the ingots poured with the hot top is rapidly becoming more proficient. The ingots are stripped from the ingot molds by inserting hooks under the pins, which were inserted into the metal during the teeming operation and the ingots are stripped nine at a time. The ingots are then carefully placed upon racks and properly tagged with metal tags and taken to the ingot storage yard.

The billet-size ingots are heated for direct rolling to the finished product in a continuous reheating furnace, which is either gas or oil-fired. The soaked billet-size ingots are rolled to the finished product on a nine-stand continuous mill having two auxiliary looping stands. When rolling strip the ingot is reduced in the first four passes in the roughing stands, the top end is then automatically cropped after leaving the fourth stand, and the bar is mechanically conveyed back to the No. 1 stand, re-entered and given four additional passes before it is conveyed to the next four continuous stands of the strand mill. After the four passes in the strand mill, the bar continues through the two looping strands then on to a coiling table to be coiled into a single strip coil.

When rolling bars, flats, angles or other merchant sections on the continuous mill, either the single or the double breakdown system is employed in the roughing mill, depending upon the size of finished product, which

in turn determines the size of the billet-size ingot that is to be used. On occasions bars are mechanically conveyed from the continuous roughing mill to a four-stand looping mill which is located in an adjacent building which runs parallel to the continuous mill building. These operations are performed without intermediate breakdown and subsequent rolling.

Single strip coils are produced in sizes ranging from ¾ in. x 20 gage to 2 ft 4 in. x 16 gage, B.W.G. This material is used for various purposes such as box strapping, cotton ties, beaded hoop, cooperage hoop, cold formed angles and channels, tobacco hogshead hoop, metal furniture, electrical outlet boxes and many others.

The merchant sizes range from ¼ in. to 1¾ in. rounds and squares both plain and deformed. Small angles from ¾ in. x ¾ in. x 7/64 in. to 2 in. x 2 in. x ¼ in., flats from ¾ in. x 12 gage to 4 in. x ¼ in. and the general run of other small merchant shapes.

This particular type operation lends itself very favorably to a flexible production of products consistent with maximum and minimum capacities of the rolling mill equipment without the necessary blooming or breakdown operation as is the case when large steel making units are employed.

MANUFACTURE OF ELECTRIC FUSION WELDED PIPE

By J. H. MIDDLETON
Chief Metallurgist, Southern District
Republic Steel Corp.
Gadsden, Ala.

▲ THE Republic Steel Corp. has built a mill at Gadsden, Ala., to manufacture expanded steel pipe by the electric fusion, submerged-arc welding process. The mill was designed to make pipe with outside diameters from 20 to 30 in., inclusive, and wall thickness from ¼ to ⅜ in., inclusive. The pipe is used for transportation of natural gas, oil or water. The plates used are rolled in an adjacent mill.

The process is basically the same for all wall thicknesses and diameters, and is divided into three groups of operations. These three groups are: (1) plate preparation and forming, (2) seam welding, and (3) sizing and finishing.

The first group of operations machine and shear the plates to predetermined sizes, depending on the size of pipe to be made. The plates are also edge formed and rolled into the cylinders to be welded into pipe.

The second group of operations weld the pipe both outside and inside. The welding is done by the submerged-arc process and uses twin arcs, one direct current and one alternating current at approximate speeds of 45 in. per min.

In the third group of operations the pipe is sized and finished on the ends for field welding. The ends of each pipe are mechanically expanded to size and then the pipe is hydraulically expanded approximately 1½ per cent in fixed diameter dies. The hydrostatic pressure test specified is made on the hydraulic expanding machine after the pipe has been expanded. After this operation, both ends are faced and beveled at the same time. The pipe is inspected inside and outside, then weighed and delivered to storage and shipping skids. The pipe can be loaded on railroad cars or on trucks.

The specifications require physicals of 52,000 psi yield strength, 65,000 psi ultimate tensile, and 22 per cent elongation as minimum values. Approximately 80 per cent of the final physicals are obtained in the plate, and the other 20 per cent comes from the rolling and expanding of the pipe to final size.

MODERN BLOOMING MILL PRACTICES

By D. W. LLOYD
General Superintendent
Brier Hill Works
Youngstown Sheet and Tube Co.
Youngstown, Ohio

▲ THIS paper presents some of the surface defects encountered in semi-finished steel blooms, slabs, and rounds. The sources of these defects are divided into four groups: (1) open hearth, (2) soaking pits, (3) rolling mill and (4) conditioning yard. The characteristic appearance of the various defects is illustrated and the mechanics of their formation indicated.

Open hearth defects are attributed to sulphur content, pouring pit practice, and deoxidation practice. Soaking pits are responsible for burning, over-heating, under-heating, uneven-heating and thermal shock. In the rolling mill there are laps, scratches, over-fill, underfill, and other defects of a mechanical nature. Poor conditioning by scarfing or chipping results in laps, seams or slivers in subsequent rolling operations.

The occurrence of some of these defects can be controlled by close supervision, but a great many are reduced only at the expense of operating costs.

TECHNICAL ASPECTS OF NORTHERN AND SOUTHERN BLAST FURNACE PRACTICE

By C. G. HOGBERG
Assistant to Chairman of Blast Furnace Committee
United States Steel Corp. of Delaware
Pittsburgh, Pa.

▲ THE principal differences in blast furnace practice between the north and the south are largely brought about by a major difference in the analysis of iron ore. A typical Mesabi ore will analyze approximately 50 per cent natural iron, compared with about 36 per cent natural iron for ores mined in Red Mountain in the Birmingham district. The fact that the Birmingham ores contain fairly large amounts of lime in combination with acid gangue does not justify a comparison on the basis of iron content alone. However, despite the lime content, blast furnace practice in the Birmingham district is characterized by slag volume in excess of

2000 lb per ton of iron, compared with 800 to 1200 lb in the north.

The high slag burden in Birmingham practice has a marked influence on thermal requirements, and naturally increases the coke consumption rate. This increase in fuel rate appears to be equivalent to more than 50 lb of carbon per 100 lb of slag. Because of the higher fuel requirement, higher blast rates are necessary for satisfactory iron production performance. These higher blast rates are made possible by sizing the ores through screening and agglomerating the fines. To compensate in part for the higher blast rates and higher fuel requirement in the south, the furnaces must be provided with more generous proportions of working volume relative to hearth area than is required for furnaces in the north.

The paper contains a detailed analysis of the chemical and thermal phases of blast furnace practice on a large furnace in the south compared with similar data for large northern furnaces utilizing both sized and unsized Mesabi ores. Some observations are made on stock descent in both districts as well as on the effect of relatively coarse ore burdens on lining erosion above the mantle.

SOME ASPECTS OF ANNEALING ATMOSPHERES USED IN THE UNITED STATES FOR TIN PLATE STRIP

By JAMES R. TRIMBLE
Assistant Manager
Department of Metallurgy, Inspection and Research
and
J. ERNEST HILL
Metallurgical Engineer, Sheet and Tin Mills
Tennessee Coal, Iron and Railroad Co.
Birmingham, Ala.

▲ WITH the introduction of cold reduced strip for the production of tin plate, controlled atmospheres for use in annealing became a necessity. The approximate chronology of the use of the protective atmospheres in annealing tin plate in the last two decades is represented by fuel gases, deox (DX) gas, lean (NX) gas, nitrogen-hydrogen (NH) gas. One of the requirements of the gas is the production of bright, clean strip after annealing. All of the above prepared gases may be produced from partial combination of fuel gases. The NX gas has the water vapor and CO_2 removed after combustion. The NH gas produced from fuel gas has the water vapor, CO_2 and CO removed after combustion. NH gas may also be prepared by adding H_2 or cracked ammonia to nitrogen gas of acceptable purity from an oxygen plant.

The gas reactions during the heating and cooling cycle have long been recognized, however, the full effect of these reactions on the corrosion resistance of the tin plate as measured by pack life is in a state of current investigation. Tests to date indicate that tin plate annealed in the presence of those gases which support a strong water gas reaction, such as DX during annealing, suffer a decrease in corrosion resistance, particularly on the edges of the strip. This in general has not been found to exist with the use of NX gas and apparently has been completely eliminated with the use of NH gas. Certain work is being done toward the development of a rapid test for the determination of the corrosion resistance value of tin plate, and the correlation of this test with the actual pack test values.

RECENT DEVELOPMENTS IN BLOOMING, BAR AND BILLET MILLS

By A. F. EISEL
Chief Roll Designer
United Engineering and Foundry Co.
Pittsburgh, Pa.

▲ THIS paper describes in detail the new installation recently placed into operation at the Lorain works of the National Tube Co. These mills are identified as the No. 4 blooming, bar and billet mills, designed to operate as a coordinated production unit and occupying a single modern building. The various units consist of one 46 in. x 100 in., 2-high, reversing blooming mill followed by a 38 in. x 96 in., 2-high reversing bar mill, either or both mills delivering blooms or slabs to a six-stand continuous mill, followed by a final four-stand continuous mill. These units roll semi-finished steel such as blooms, billets, tube rounds and skelp slabs for further processing into finished products of the company.

The description places particular emphasis on the six-stand and four-stand continuous mills which the writer believes to be an outstanding development in rolling mill operations. Illustrations are given of the entire layout indicating the flow of material from ingot to storage, and of the six-stand and four-stand mills showing method of rolling along with several outstanding features.

Built for high production with quality and flexibility for diversification of semi-finished products, these mills are an outstanding improvement and addition to our country's steel producing facilities.

DEVELOPMENTS IN THE DESIGN OF D-C MOTORS AND GENERATORS FOR ROLLING MILLS

By B. H. CALDWELL, JR.
Section Engineer, Large D-c Motors and Generators
General Electric Co.
Schenectady, N. Y.

▲ PHENOMENAL advances in steel rolling techniques have been made during the past decade. Delivery speeds for tandem, cold strip mills have been greatly increased from some 3800 fpm to 6200 fpm. Rod and tube mills have been greatly improved to increase

production, to improve quality of product, and to reduce scrap. Extended use has been made of electric drive for fast reversing mills for rolling blooms, slabs, and plates both for new mills and for replacement of steam engine drives.

These advances have presented a challenge to the designer of d-c motors and generators. In order not only to meet this challenge but also to anticipate and be prepared to meet future requirements, many important developments have been made in the design of such equipment. As an illustration of the scope of this work some of the more important contributions will be described.

Rod and tube mill motors—Reference is made to earlier papers on the subject of "Impact Speed Drop" and its influence on the operation of these mills. Range of values of impact speed drop for normal and special designs is given and discussed. Performance data for a typical installation is presented.

Tandem cold strip mills—Design problems encountered in matching motor characteristics for the various stands of this type mill are described. Reference is made to the importance of transient characteristics. Where individual generators are used, the special problems in matching characteristics are analyzed.

Fast acceleration and deceleration of motors—More emphasis is being placed on the ability to accelerate or decelerate motors rapidly. Basic mechanical as well as electrical considerations introduce limits. These are described and evaluated.

Fast reversing applications—Discussion is directed primarily to problems relating to the "twin drive." Mechanical features are included, such as interchangeable rotors, bearing and pedestal construction, and treatment of joints between coupling-shaft, rotor punchings-spider, etc. Electrical features are discussed, as factors determining insulation life, commutation performance, and reversal time.

Short circuits—Reference is given to important contributions on this subject which have been recently published and to further work now in progress. This information is an important contribution, and should prove useful as a guide in providing proper protection for d-c machines.

CONTINUOUS CASCADE PICKLING

By W. H. STUCK,
Metallurgical Investigator
Jones and Laughlin Steel Corp.
Aliquippa, Pa.

and

J. H. ABRAMS
Technical Representative
American Chemical Paint Co.
Ambler, Pa.

▲ THIS paper describes the new Jones & Laughlin Steel Corp. 42-in. continuous strip pickler, located at their Aliquippa works. The description of this pickler, one of the most modern now in operation, includes descriptive details of the essential parts of the following units which comprise the line:

1. Processor.
2. Electric flash welder and trimmer.
3. Looping pit.
4. Pickling tanks.
5. Dryer.
6. Trimmer and upcoiler.

The description is supplemented by photographs of some of the more interesting units.

The paper also discusses, in some detail, Jones and Laughlin's experience with cascade pickling. The unique proportioning equipment used for controlling the continuous addition of acid and water is described. Jones and Laughlin's method for continuously adding measured amounts of inhibitor to the pickling solution is presented.

ROLLER GUIDES

By CLARK LAMBERT
Superintendent of Merchant Mills, Campbell Works
Youngstown Sheet and Tube Co.
Youngstown, Ohio

▲ MAN'S progress in acquiring the knowledge considered to be basic in our civilization is chronicled by events such as the discovery of the art of working metals and the invention of the wheel. The wheel, applied as a mechanical element to machines, was known in ancient civilizations. In historical literature it is referred to as a criteria used by archeologists for determining the level of civilization of a people. The concept of devices which we call rollers is an ancient one. A roller can be considered a higher development of the primitive wheel to the extent of qualitative refinements.

With respect to modern day industrial equipment, the probability of a novel application of rollers would seem remote. Nevertheless, the development of the use of rollers in guide equipment has been comparatively recent. The reason for this is not entirely due to the fact that human ingenuity lagged. Rather, the successful development of this production tool required materials that would insure a reasonable life under the destructive action of heat, pressure, scale and water. The advent of hard cast alloys, carbides, tool steels, water lubricated phenolic bearings, low cost high efficiency ball and roller bearings and superior metallic bearings has made the application of rollers to rolling mill guides feasible in many cases.

The substitution of roller twist guides for friction guides has alleviated serious surface quality difficulties; particularly in the case of special requirement steels. When bars, comparatively large in cross section, are to be twisted in short distances, for example, in a bar mill continuous roughing train, the turning couple may be too large for a friction twist guide to produce without heavy shearing. Roller guides are the answer, wherever a high torque twist, free of shearing, is demanded. Surface defects on finished material traced to heavy guide shearing has been encountered by almost all merchant mill operators.

By rolling rounds with roller entry guides, it is possible to hold size to close tolerances because of a precise guide set-up. This precision, however, must extend to the setting of the rest bar and the rolls. The rest bar must be level, the rolls plumb and passes alined, otherwise difficulty may be encountered in holding size for an extended period. Roller bearing outboard thrust bearings are a valuable adjunct, and make a perfect teammate for roller guides. Under these conditions, the dimensions of a round should not vary from the effects of leaning ovals or crossed rolls.

Although many of the ideas and improvements pertaining to guides originate among mill personnel, the development of these ideas must be worked out on a drawing board. The guide designer takes it upon himself to correlate suggestions and requirements to the physical dimensions and conditions of the mill.

In reviewing the situation with respect to materials, it must be admitted that it is difficult to specify the correct material in the first place in every case. Many times exploratory trials must be made. The best performing material is not always used. For instance, our preference is cast steel for twister housings because of the inherent rigidity and freedom from warp. Nevertheless, we use welded fabricated steel construction in most instances because of the savings in patterns and the availability of flat rolled steel. The maintenance cost of this construction has not been too high.

The writer is well aware that other organizations have developed successful practices with regard to roller guides which could richly supplement thoughts in this paper. He has drawn on his own experience for much of the material. Conditions on other mills may require practices at variance with ideas expressed. Without doubt, there is much to be said and done on this subject.

19-STAND ROD MILL OF KEYSTONE STEEL AND WIRE CO.

By WM. HERMAN
Superintendent, Rolling Mills
Keystone Steel & Wire Co.
Peoria, Ill.

▲ IT is common practice to three strand a mill to increase the tonnage. When this is done, there are three strands in the mill from the first stand to the last. The Keystone Steel and Wire Co. has developed a method whereby a three strand average is maintained with a two-strand rougher and the use of four passes in the intermediate and finishing mills. This mill is a 19-stand mill with two loops. The 9-stand rougher is two-stranded, while the last 10 stands have 2, 3 or 4 bars in the mill, thus averaging 3 bars continually. This is accomplished by the use of long loops and a switching device at stand No. 7. This method has a certain amount of flexibility which makes it possible to increase the number of strands to something over a 3-bar average. A maximum of 3½ bars can be obtained with the use of four passes and four reels. Anything over 3½ bars would require the use of six passes and six reels.

There is a definite relationship between rougher speed, loop length, and billet weight. The greater the weight, the slower the speed and conversely the less the weight, the higher the speed to maintain a given loop length. The tonnage is directly proportional to the speed of the rougher; therefore, it would be desirable to operate the rougher at the highest possible speed to obtain the maximum output, however, the weight of the billet must be considered also.

In making a layout of this kind, there is a choice between using small billets for the maximum output or sacrificing some tonnage to use a larger billet. The development and operation of this method is described and explained in detail.

THE BLOOMING MILL — STEEL INDUSTRY'S IRON HORSE

By R. H. WRIGHT
Industry Engineering Department
Westinghouse Electric Corp.
Pittsburgh, Pa.

▲ THE blooming mill has always been the iron workhorse of the steel industry. It has never been noted for high delivery speeds, yet it has continued to meet all the demands of an increasing number of high speed finishing mills of all types. When it is considered that most of the steel that is rolled still passes through the blooming mill and that about 85 per cent of the existing installations are over twenty years old, the record of the blooming mill seems remarkable.

The rising tonnage capacity of these installations has been brought about by constant improvements in ingot heating equipment and mill equipment, and by major improvements in electrical equipment for main drives and auxiliaries. In the early days of the electrification of the industry, no one had a full conception of the tonnage possibilities of a particular installation. Likewise the capacity of the available electrical equipment was quite limited. Through gradual increases in motor capacities and a better understanding of their application, the present tonnages have been obtained.

Increased capacity of the main drive equipment has been obtained without increasing the physical size of the parts. This has made it possible for many of the old drives to be rebuilt for materially greater capacity with no changes in the foundations. New control for the main drives and new adjustable voltage auxiliaries have also been beneficial in a number of cases. The output of many of the older electrically driven mills could be improved by such means, and the electrification of many of the remaining steam drives would reduce operating costs as well as increase the output.

The present tendency for new installations is to design for specialized work and to use more power, with twin-motor drive for the main rolls and adjustable voltage for the auxiliaries.

CHECKER BRICK DESIGN, CONSTRUCTION AND USE

By JAY J. SEAVER
Jay J. Seaver Engineers
Chicago, Ill.

. . . . experience with checker work in blast furnace stoves would indicate that open hearth checker brick should not be thicker than 2½ in. . . . .

▲ CHECKER brick, which derive their name from the pattern in which they were laid, were first used in regenerators as a medium to recover sensible heat of the waste gases from fuels by William Siemans in about 1861. Regenerators, which are chambers of brickwork filled with brick to form checkers, are made in many designs, shapes, and sizes. Those for the glass plant and open hearth are usually rectangular in shape and vary in size according to the judgment of the designer and operator, generally with the greatest dimension horizontal. The chambers for these regenerators are usually formed by brick walls with sprung arch roofs. These walls are securely tied together by heavy eye beams or channels, serving as buckstays and binding, connecting the top and bottom.

The regenerators, which serve to heat the air for the blast furnace, are commonly known as stoves, and consist of brick walled cylinders, enclosing a combustion chamber and set of regenerative flues, all encased in an airtight steel shell with a flat bottom and dome shaped top. The stoves are from 20-25 ft in diam, with a height of four to five times their diameter.

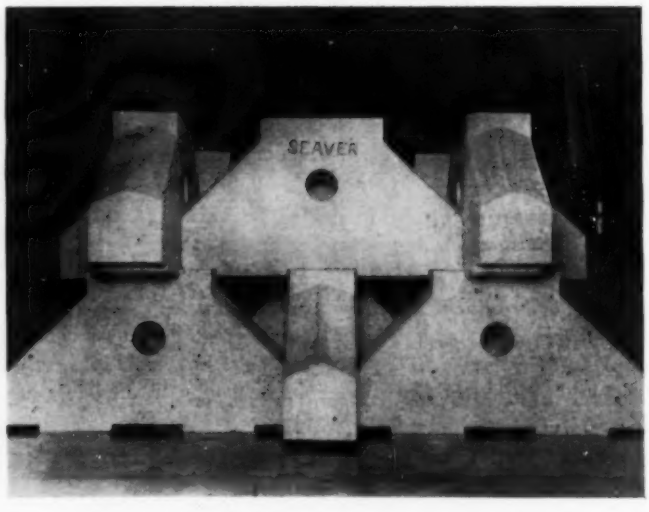
The earliest regenerators were used on steam engines and soon thereafter were applied in consecutive order to glass furnaces for making glass, open hearths for making steel, and blast furnaces for heating the air.

Checker brick for regenerators have many requirements to meet. They must be refractory enough to stand the highest temperatures, must be resistant to the chemical action of the dust and solids that are carried in the hot gases, must not be affected by sudden changes of temperature, must be able to absorb and release heat, must have physical strength, must have load bearing capacity without distortion at working temperatures, must have a low coefficient of expansion, and must have a large exposed volume with high heating surface per cu ft of checker volume.

Some of the fundamental design characteristics of a good checker brick are that they must be simple, stable shapes with the center of gravity on or below the center, with the longest dimension horizontal, rather than in a vertical position, when laid in place. The brick should have a simple positive lock, so that they are tied together into a complete unit, without being dependent on the outside walls to keep the locks in mesh. They must be of such a design that they are not materially affected by expansion or contraction of the brick.

The brick should be designed to permit cross ventilation, or equalization of pressure between the various checker flues, so as to work the whole checker area and

Figure 1 — Cross vents in checker brick allow better circulation.



protect the regenerator against loss of a complete checker flue. If a brick bat, or plug, should stop up a flue, these side openings would allow the products of combustion to bypass to the four adjacent flues around the plug and go back into the original flue again, thereby losing only the plugged up portion. The bypasses should be arranged in a staggered pattern, so as to cause a zigzag motion and turbulence of the gases.

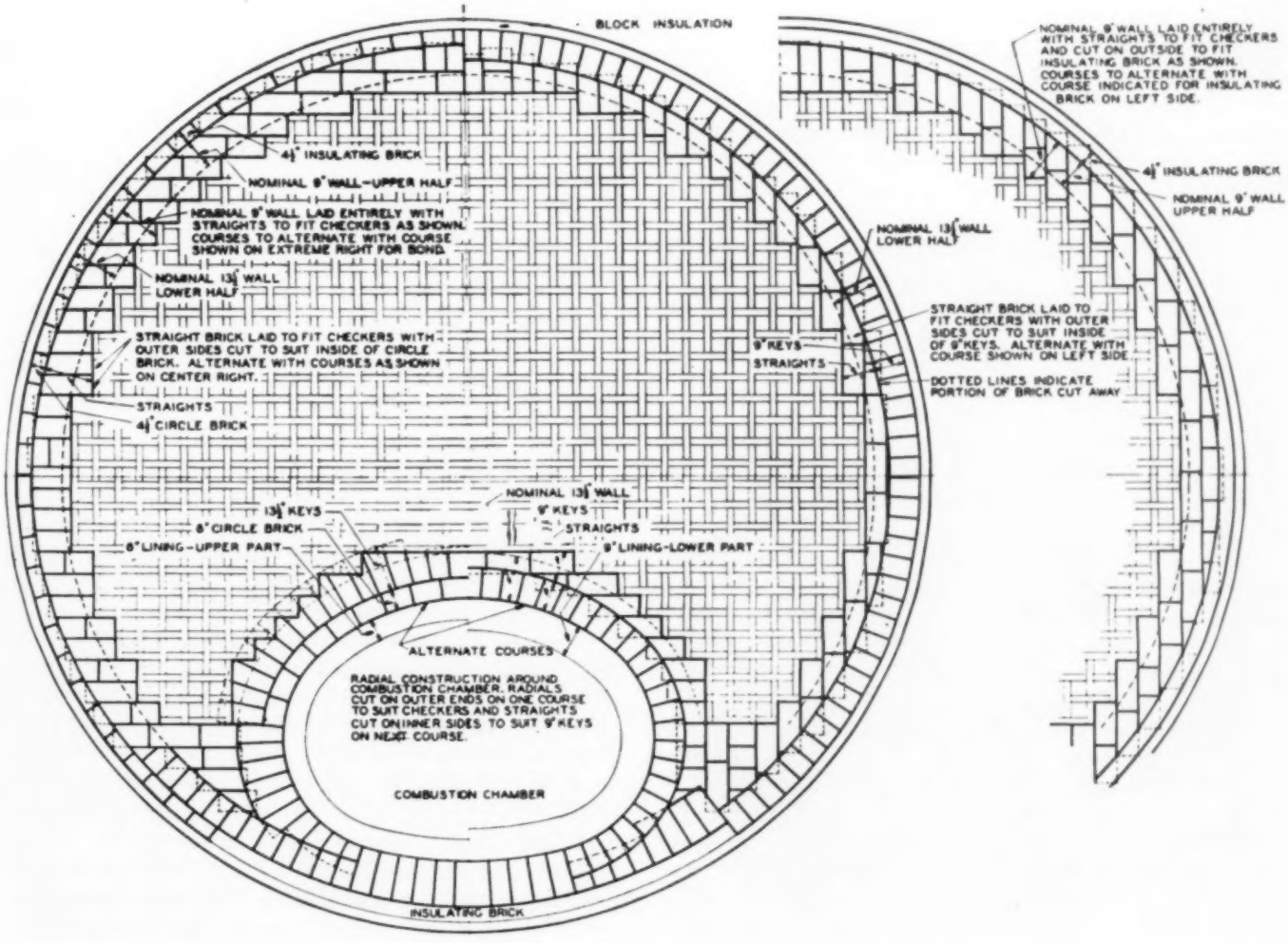
It is important that the checker brick should be stable, with its longest dimension in a horizontal position. If the checker brick is a long slim one, with its long dimension laid up in a vertical position, it has a comparatively small base, and the brick has to be inclined only a small amount, before the center of gravity is off the middle third of the base, then it tends to lie down in a horizontal position. This is most noticeable in hot blast stoves. Even checker brick which are nearly square or rectangular in shape, and not properly locked, are subject to spiraling, twisting and shifting.

This condition of twisting and shifting has caused, and is still causing, many failures of checker systems. As a temporary remedy, to correct these failures in stoves, several feet of the existing checkers have been removed and replaced with large rectangular brick laid in a basket weave pattern, with a sacrifice of heating surface for structural strength. In order to further correct this condition, a simple improved basket weave checker brick with locks and larger exposed volume and heating surface could be used.

No explanation of the cause of this twisting and shifting has ever been advanced, but it is very evident from many observations made, especially of hot blast stoves, that it is caused by rotation of the earth. The earth north of the equator rotates in a counter-clockwise direction, and south of the equator in a clockwise direction. Since our location happens to be north of the equator, it will be found that all the checker brick have rotated in a clockwise direction. This is due to the fact that the bottom of the regenerators, mostly stoves, are following the earth, while the top sections have a tendency to lag behind, and give the appearance of the brick rotating clockwise, similar to the spiraling water leaving the bath tub. Thus, the checker brick in a hot blast stove which have been in use, will be shrunk and twisted in a clockwise direction. There is no way to correct or guard against this condition, except to lock each brick, top and bottom, and not depend too much on the walls to hold the checkers in place.

Several forms, shapes and sizes of checker brick have been designed and used in regenerators. One of the most common types of brick used, is one of rectangular shape, which is laid up in horizontal courses and is generally called basket weave. The bricks are laid up in a way to form square flue openings, from top to bottom

Figure 2 — Cross section through blast furnace stove.

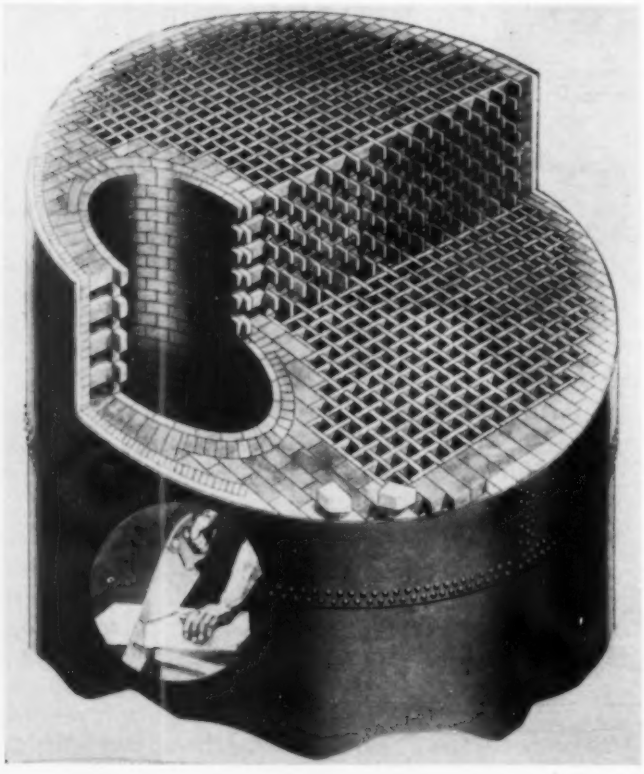

BLOCK INSULATION
4½" INSULATING BRICK
NOMINAL 9" WALL—UPPER HALF
NOMINAL 9" WALL LAID ENTIRELY WITH STRAIGHTS TO FIT CHECKERS AS SHOWN. COURSES TO ALTERNATE WITH COURSE SHOWN ON EXTREME RIGHT FOR BOND.
NOMINAL 13½" WALL LOWER HALF
STRAIGHT BRICK LAID TO FIT CHECKERS WITH OUTER SIDES CUT TO SUIT INSIDE OF CIRCLE BRICK. ALTERNATE WITH COURSES AS SHOWN ON CENTER RIGHT.
STRAIGHTS
4½" CIRCLE BRICK
13½" KEYS
8" CIRCLE BRICK
9" LINING—UPPER PART
NOMINAL 13½" WALL
9" KEYS
STRAIGHTS
9" LINING—LOWER PART
ALTERNATE COURSES
RADIAL CONSTRUCTION AROUND COMBUSTION CHAMBER. RADIALS CUT ON OUTER ENDS ON ONE COURSE TO SUIT CHECKERS AND STRAIGHTS CUT ON INNER SIDES TO SUIT 9" KEYS ON NEXT COURSE.
COMBUSTION CHAMBER
INSULATING BRICK
NOMINAL 9" WALL LAID ENTIRELY WITH STRAIGHTS TO FIT CHECKERS AND CUT ON OUTSIDE TO FIT INSULATING BRICK AS SHOWN. COURSES TO ALTERNATE WITH COURSE INDICATED FOR INSULATING BRICK ON LEFT SIDE.
4½" INSULATING BRICK
NOMINAL 9" WALL UPPER HALF
NOMINAL 13½" WALL LOWER HALF
STRAIGHT BRICK LAID TO FIT CHECKERS WITH OUTER SIDES CUT TO SUIT INSIDE OF 9" KEYS. ALTERNATE WITH COURSE SHOWN ON LEFT SIDE.
9" KEYS
STRAIGHTS
DOTTED LINES INDICATE PORTION OF BRICK CUT AWAY

of the regenerators, with solid walls in between each flue. The basket weave pattern has been tried, tested in service, and proven to be the best basic pattern for all regenerators over a period of years.

Structurally, it has met all requirements, but the ratio of brick volume to heating surface is too high for maximum efficiency. In order to increase the heating surface per unit of checker volume, this brick has been changed by cutting off the upper corners, to form by-passes, and placing a hole in the middle. This change gives about 30 per cent more heating surface per unit of checker volume, and permits equalization of the gases over the entire checker area. Projections, or lugs, have been added to the bottom of each brick, which fit into the space from which the upper corners were removed, in the next lower course. This locks each brick, top and bottom, so that they cannot twist or shift. A double bevel has been added to the top surfaces from which the corners were removed, so that no flat horizontal surfaces are exposed for the accumulation of dirt. This type of brick is shown in Figure 1.

Checker systems, especially those with solid wall chimney flues, have unbalanced heating areas. This is caused by deflection, throttling, and uneven distribution of the gases entering through unequal heights of sprung arches above the top of the checkers, and unequal draft from the chimney valves. Tests have shown that where gases come into open hearth regenerators at an abrupt angle, that the flues in direct line with the gas flow do more work than those out of the main path. Stoves, with one chimney valve, often show a deep imprint on top of the checkers and a hard worked area in a line from the combustion chamber to the chimney valve. Whereas, stoves with two chimney valves, show a similar hard worked area, starting at the combustion chamber and fanning out into a V-shaped area above the two valves.

Figure 3 — In this hot blast stove section, insulating brick are fitted in place between the shell and checker brick.



The glass and open hearth regenerators can be improved by replacing the sprung arches with suspended arches. This will provide uniform cross-sectional area above the top checkers, permit space for additional checker volume, and will take the side thrust off the side walls. The unequal distribution of gases in stoves can be improved by the use of cross vent checker brick, which allows equal pressure in the checker flues, at any cross section.

In the early design, most of the regenerative stoves were three or four pass, of the center combustion type, with checkers radiating to the outside ring wall. This arrangement gave radial checkers, with varying dimensions, and required many different special brick shapes.

The design was changed and improved, until it became a two pass type, which is still used in many plants. The center combustion type stove was favored by operators from the standpoint that the hottest part of it was in the center and heat radiated from it was absorbed by the surrounding checkers, without too much heat loss to the outside wall. The checkers were gradually changed from radial to square openings, which reduced the cost of special shapes and increased the heating surface.

The side combustion stove design soon followed, but considerable development had to take place to make it a substantial structure. At first, the combustion arch on the checker side was too flat, and many of them split and buckled at the top, allowing the checkers to push over into the combustion chamber.

The combustion chamber was gradually changed into a distorted ellipse, or circular shape, which are now standard designs. The original checkers were laid up in a basket weave pattern with 9-in. straight brick, giving 9 x 9 in. openings and 4½ in. thick walls, with the lower four-fifths of the checker brick made of second quality and the upper one-fifth of first quality material. The brick were laid flat and each course was continued and rough cut on the packing line, about 2 in. from the steel shell.

The packing space was filled at each scaffold height, or every four feet, with dried bank clay. The clay would eventually settle down into the lower part of the packing space and leave the upper section void. This often caused hot spots on the shell so that the shell had to be drilled and plastic clay pumped inside.

In order to compensate for settlement of the packing, the skew back brick were provided with a two in. square lug to hold them away from and keep them from forming a tight seal at the base of the dome. As the packing settled, additional clay packing was poured into the top manhole of the stove, between the brick and steel dome. This clay would trickle down and keep the space filled.

Then another difficulty soon arose from the surplus packing at the base of the dome. This was excess compression of the clay, from expansion of the brick work.

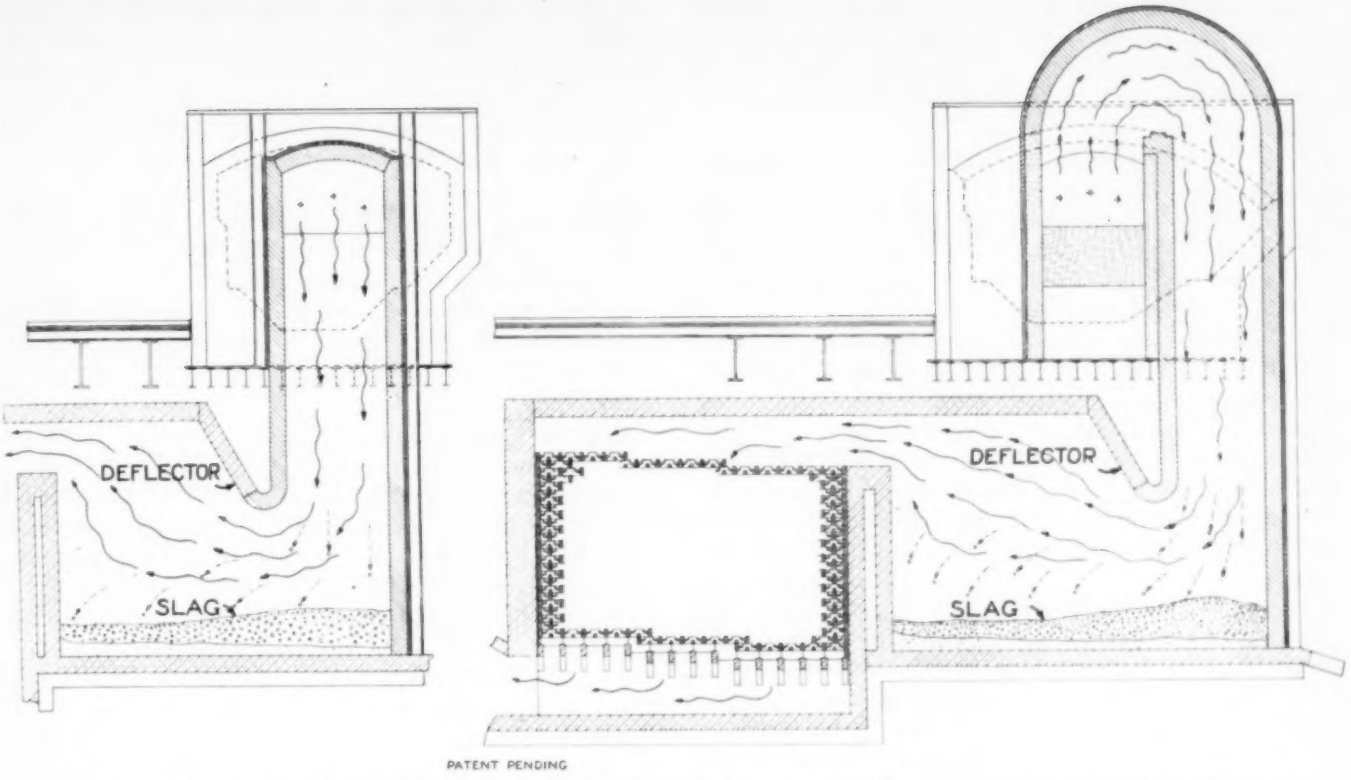


Figure 4 — On the left is shown a deflector for conventional open hearth furnace, and on the right is shown a deflector for a new open hearth furnace.

The expansion often placed such stress on the steel shells, that many of them were ruptured horizontally, and had to be provided with steel expansion joints.

Rapid improvement of the entire stove design followed immediately. This included use of block and brick insulation of various thickness, as required in the different heat zones, smaller radius arches in the combustion chamber, a steel band to take the horizontal stress of the brick dome, metal columns, girders and grids for supporting the checker system, checker brick of first and super duty quality materials with thinner walls, and greater heating surface per cu ft of checker volume.

Much of the stove development has come about with the use of better cleaned blast furnace gas, with improved stove efficiency. The old stoves used from 35 to 50 per cent of the gas produced to heat the checkers to give air temperatures of 1000 F to 1100 F, with a chimney temperature of 700 F to 800 F. The same size stoves, with improved checkers and increased wind volume, are able to carry 1600 F straight line heat with a 350 F chimney temperature on a consumption of only 20 per cent of the gas produced, or stove efficiencies of 80 to 90 per cent are possible with present designs.

The side combustion stove has now taken the lead for general use. It gives about 10 per cent more heating surface than the center type, with the shells and checkers of the same size.

Most checker brick shapes are best adapted for laying in rectangular shape regenerators, but laying them in stoves with round ring and combustion walls is somewhat more difficult. Considerable discussion still continues as to the most practical way to connect the back-up brick between the square checker brick and the round steel shells, without leaving small triangular pieces, which may fall out of place and cause a wedging action.

When brick and block insulation came into use, the ring wall was changed from right angle alternated continuous brick courses, which were cut off near the shell, to a combination key brick course which abutted against the insulation on the outside, and came up near the outside corners of the checkers on the inside. If not, it changed the brick cutting line from near the shell to near the checkers. This design is shown on Figure 2. It is in general use today, but continues to give some trouble.

The only improvement accomplished with the key ring wall course, is that it remains in place when the checker brick contracts, but it still allows the loose brick inside of it to fall out of place.

A practical and simple design is shown on Figure 3. Here the back-up brick are all continued to near the shell, then insulating blocks, which are the same thickness and width as the back-up brick, are sawed and fit in place between the square ends of the brick and the shell. The insulating blocks can be cut more easily and accurately and at less cost than the fire clay brick, and give more resiliency to compensate for expansion and contraction of the brick. This also eliminates cutting of the fire brick.

Checker brick for each set of regenerators should be limited to one shape, if possible. This will reduce manufacturing and laying costs, and inventory storage space. Checker brick should not be oversize, as an accumulation in size of each brick not only gets the checkers out of alinement, but causes extensive cutting at the walls.

For each checker brick thickness, there is a definite size flue opening which gives maximum heating surface per unit of checker volume. If the flue is increased or decreased from this size, the heating surface will be decreased.

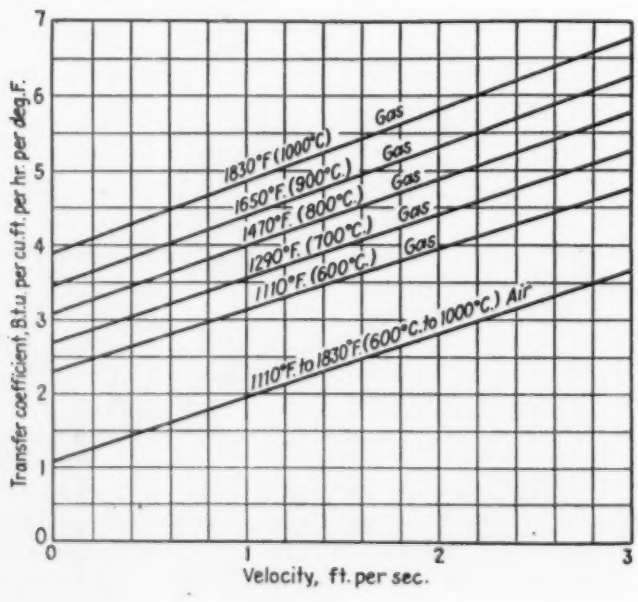
Stove linings are often laid up with flat face sections inside the ring wall and on the back side of the combustion wall. These flat walls vary in number from four to eight, or more, according to the shape of the checker brick. This design is used as an aid to keep the checker brick in mesh and stop them from spiraling.

A situation often arises, where a plant has been built, with regenerators of the proper size to meet their current requirements, but at a later date the furnaces are increased in size, with increased demand for checker heating surface. Most regenerators are limited to their original size by the space which they occupy, so that it becomes necessary to increase the heating surface in the original chambers, or shells, to fit the new demand.

To meet these conditions at the open hearth, the products of combustion should have the heavy solids removed by a suspended refractory deflector placed over the slag pockets, in front of the checker chambers, which will require them to turn through an angle of 180 degrees. This will cause a large percentage of the heavy solids to be deposited in the slag pockets, as shown on Figure 4. Then the velocity of the exit gases going through the regenerators should be increased, to eliminate deposit of the lighter solids in the checker chambers, and give higher heat exchange, as heat transfer is in direct proportion to the velocity, as shown on Figure 5.

These changes will permit the use of smaller checker openings, with thinner brick and increased heating surface. Then a small dust catcher should be placed after the primary regenerators, which would be followed by two secondary vertical regenerators with small checker openings. To the two secondary regenerators, a short stack, with valves and fans, would be connected to take the final discharge of the products to the atmosphere. With such an arrangement, a high percentage of the heat can be absorbed and reused, thereby materially increasing the efficiency of the present open hearth.

Figure 5 — Heat transfer coefficients between gas and brick, and between brick and air are given by these curves for various velocities and temperatures.



For stoves to meet the above conditions, the blast furnace gas should be fine cleaned, then fluted tubular inserts can be installed into the flues from the top, which would increase the original heating surface about 140 per cent. If fine cleaned gas is not available, the top cnecker brick can be removed and replaced with improved brick, to give the additional heating surface required.

Basic brick have been used successfully to replace the top checker brick in glass plants, and their use has resulted in longer checker life, without clogging or much erosion. Although basic brick cost about five times as much as fire clay brick, they are being used to greater depths in these regenerators, with the feeling that the additional cost is justified. Similar trials should be made by the open hearth to test their economy.

Checker brick wall thickness is often determined by two opposite and different views. In the open hearth, stability is usually considered to be of first importance, whereas thickness in stoves is more often decided by the amount of heating surface desired. Consequently, most checker brick walls in the open hearth are too thick, and those in the stoves are too thin.

Some recent tests, made on checker brick approximating open hearth heating and reversal conditions, show that the outer ½ in. of the vertical surface of the brick absorbs two-thirds of the heat taken up or given off by a checker brick, and that the first one in. absorbs 90 per cent of the total heat exchanged.

From the above tests, it should be conclusive evidence that the open hearth brick walls should not be thicker than 2½ in. to meet all requirements, especially if they are locked in place. Thickness of checker brick walls for stoves should be determined after giving more consideration to stability on account of the height and shape of the structure in which they are contained. To meet the general requirements of heating surface, exposed volume, stability, continuous service, and long life, they should not be less than 1½ in. thick for the basket weave pattern.

A stove checker system made up of improved basket weave brick, with locks, and the flues filled with fluted tubular inserts, gives a strong stable structure. It also provides high heating surface and high weight per cu ft of checker volume.

Summarizing, one of the intentions of this paper, is to bring out some of the difficulties which had to be overcome in design and construction, to improve the efficiency of the regenerators for the blast furnace. And, although these improved changes seemed radical at the time, nevertheless, they have proved to be economical, and have materially increased the production and efficiency of the blast furnace operation in the last twenty years. It also suggests similar changes, which have to be made, to capture and use the heat economically, which is now being lost from the regenerator system of the open hearth.

Developments

IN COIL CONVEYOR EQUIPMENT DESIGN

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. . . . properly designed conveyor installations permit appreciable economies in the handling of hot and cold coils . . . .

▲ IN the theme of this AISE convention the need for bettering the economy of the industry's production processes has been emphasized and it was pointed out that stronger competition will call for improved quality and better operating efficiency. Obviously, economies and better operating efficiency of strip and sheet mills require maximum utilization of existing processes, increased yield from existing mills, and improved safety conditions.

Properly designed coil conveying systems can contribute much toward attaining these objectives. Existing processes can be used to their fullest extent when served by handling systems that provide economical and safe transportation, the means for cooling hot coils, and active storage under control of mill operator. Conveyors for storing coils at the entry and delivery ends of certain finishing processes are particularly effective in reducing delays and idle mill time.

Yield is increased by conveyor systems capable of handling large tonnages of heavy coils dependably, yet gently enough to reduce damage and scrap losses to a minimum. Safety conditions are improved by reducing the number of crane movements, and by eliminating the travel of vehicles in the vicinity of mill crews.

Chain conveyors are effecting these and other economies in various processes, from the hot mill to the shipping platform. As mill builders improve their techniques, the conveyor industry is striving to protect the coils during handling operations and to serve various processing units more efficiently.

Development of powered chain type coil conveyors has passed through various stages of design, beginning with chains sliding on greased tracks, chains supported on a series of fixed rollers, and chains that push the coils over troughed rollers. The latest and most successful designs are of three general types; namely, the double strand roller chain, the wide pallet conveyor, and the car type conveyor. Each has its advantages and field of application for specific operating requirements.

The double strand roller chain conveyor (Figure 1) consists of bar link chains, 12 or 18 in.-pitch, with alloy pins extended each side for hardened outboard rollers which, in turn, are equipped with precision roller bearings. Chain pins are locked in outside bars but turn in center bars while operating around sprockets. This active bearing area of pins should be cadmium plated to serve as an initial lubricant to prevent galling when handling hot coils. Top plates 6 in. wide or more are used to provide adequate bearing for hot coils when carried on end. High carbon angles form simple tracks, and are sufficient to guide the chain regardless of conveyor length.

Figure 1 — This conveyor, used on a hot strip coil handling system, consists of two strands of 12-in. pitch, pallet-type steel roller chain mounted on 26-in. chain centers.

The space between chains allows air to circulate for cooling hot coils, and provides clearance for arms of loading, unloading and weighing mechanisms (Figure 2). For this reason, the double strand type has been particularly successful for handling hot coils on end from coiler to storage, and two installations for this purpose have been operating dependably for eleven years with relatively little maintenance. Recently, much heavier units were installed at both the entry and delivery ends of a temper pass mill for handling coils weighing as much as 76,000 lb (Figure 3). This type was most suitable, because it was necessary to locate the loading and unloading mechanisms between the chains.

A somewhat similar design is made with a single roller assembled between the chain side bars. It is used principally for short conveyors, where the additional friction from side guides is not important.

The wide pallet type of conveyor (Figure 4), in one form or another, has been used in mills for many years. Usually it was built of heavy flat or V-top pallets,

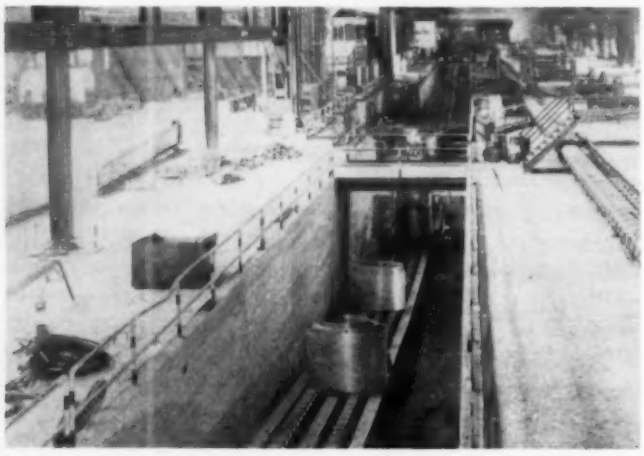


Figure 2 — Hot strip coil handling system shown includes three waffle-top transfers from coilers to conveyor line, two lift-and-turn units for 90 degree transfer of coils, and five side discharge down-tilters for automatically transferring coils to five troughed gravity roll lines from which overhead crane transports them to nearby storage area.

mounted on two strands of roller chain. Recently, however, a design was developed incorporating the chain side bars as an integral part of the pallet—in effect making a single wide chain with its advantages of alinement and simplicity. Axles, chain bars and rollers are heat treated and the latter are fitted with precision roller bearings.

This type is most suitable for carrying coils on their sides, either longitudinally or transversely. For that reason, it is used largely for serving pickle lines, cold reduction mills, cleaning lines, and similar processes. A novel variation of the pallet type was developed recently to permit applying heavy circumferential bands to coils (Figure 5). Cross rails were spaced on the top to form a continuous V-troughed grid the entire length of each 415 ft conveyor.

The car type conveyor was developed originally to transport molds in foundries, but it has proven most

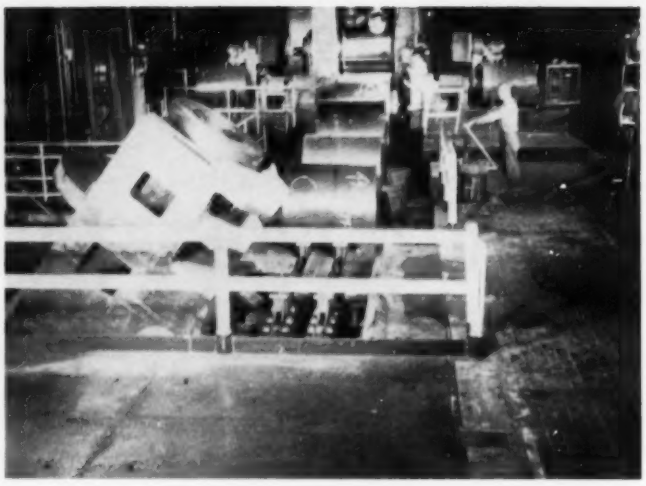
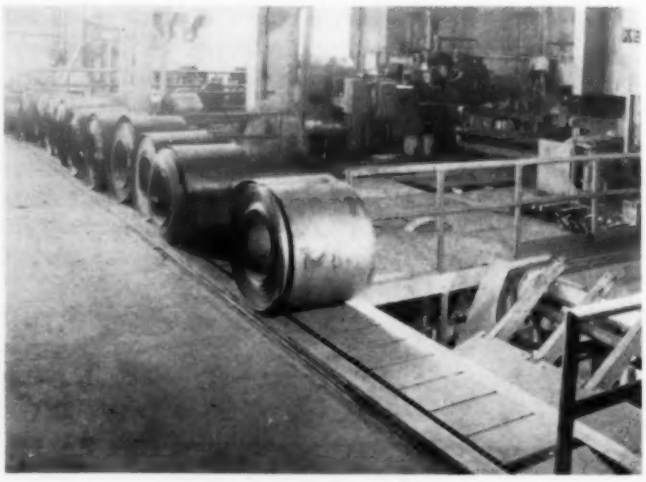


Figure 3 — Coils as heavy as 76,000 lb can be handled on this unit.

successful since its adaptation to the steel industry. See Figure 6. Current designs for handling coils consist of a series of heavy cars, each equipped with a pair of cross beams on top, spaced to carry one coil on end. Cars are connected by a single roller chain operating on a horizontal plane, which serves the dual purpose of propelling and guiding the cars. Chain may be articulated in both directions, so cars on the same conveyor can travel around corners, or up and down inclines. Of simple, massive construction, maintenance costs are quite low.

The car type conveyor is an ideal unit for cooling hot coils on end, for its beam tops combine broad bearing surfaces with ample space between for circulation of air. The coil remains on its own car from loading to unloading zones, without transfer regardless of path of travel, thus reducing the possibility of coil damage to a minimum. This feature is an advantage when numerous turns are necessary, or when cooling space is limited, for it is possible to utilize the entire conveyor for carrying in opposite directions on adjacent runs. On the other hand, when it is required to handle coils in one direction over relatively long, straight runs, the double strand roiler type occupies less space and is lower in first cost.

Figure 4 — Heavy-duty pallet conveyor is shown in service at the entry end of a continuous pickle line.



While coil conveyors improve efficiency in performing their primary functions of economical and safe transportation, they offer additional returns in the form of increased yield, by handling coils with less damage than other methods. Obviously, little damage can occur to reasonably well formed coils while they are being carried on a single well designed conveyor, regardless of its type. The real problem occurs when coils are handled to and from various units. As a result, most recent developments have been improvements in design of auxiliary devices for loading, unloading, weighing, transferring, and extending lengths of conveyors to eliminate transfers.

A recent hot mill installation includes an initial conveyor of the double strand roller type operating parallel to the mill runout table. Each of three coiler tilters delivers the hot coils to its own hydraulically operated loader which, in turn, lowers coils on end to conveyor chains (Figure 7). The tilters are retractable and the arms are provided with a device for automatically centering coils over conveyor. The loader is equipped with broad, flat tops to protect the strip edges. The operation is speeded, for the loader holds the coil momentarily, until it can be properly spaced on conveyor, allowing the tilter to retract. Other variations of this type of loader have been used, including one application where it receives coils from a unique transfer car. The car was developed to transfer coils from a second coiler to an additional loading station, thus eliminating a short conveyor and another transfer.

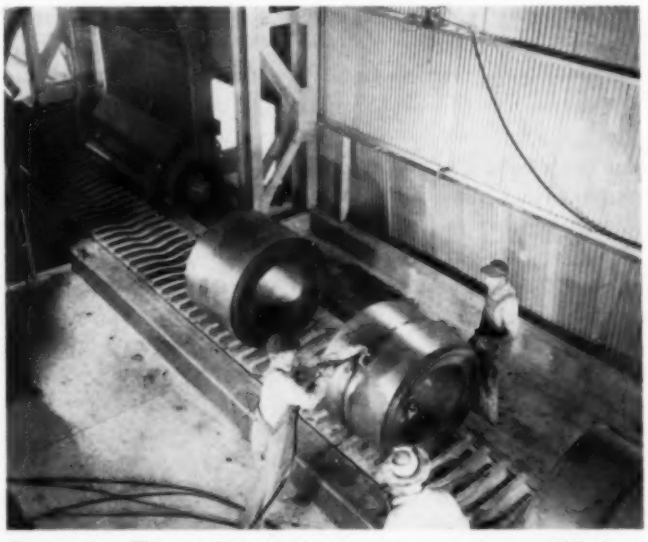


Figure 5 — The pallet type conveyor can be modified so that bands can be applied to the coils while on the conveyor.

When coils are conveyed on end, they may be removed by crane magnet or automatic tongs. Often, however, it is necessary to down-tilt them on their sides as they are unloaded, for convenience of piling by crane or truck. Early unloaders of this type were simply tilters at the end of conveyor, some with a short section of troughed gravity rolls, others with inclined table for rolling them sideways automatically. One design included a turntable to prevent rolling against the flap.

Longer conveyors required intermediate unloading stations. This was accomplished in the car type by retractile tilters having arms projecting between the car top coil carrying beams. For the double strand type a side tilter has been developed that can be located anywhere along the conveyor, or can travel from station to station (Figure 8). In order to prevent sliding or scuffing coil ends, a troughed gravity roll section of tilter moves in to support the outside diameter of coil, after which it is tilted to a stationary section of gravity rolls for removal by crane or ram truck.

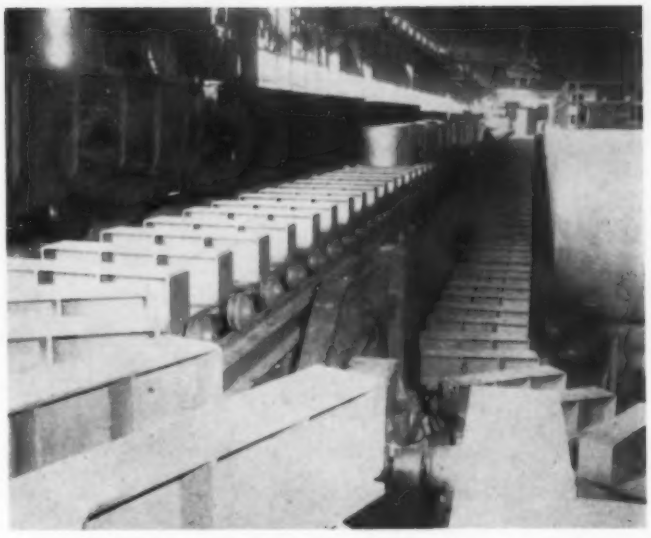
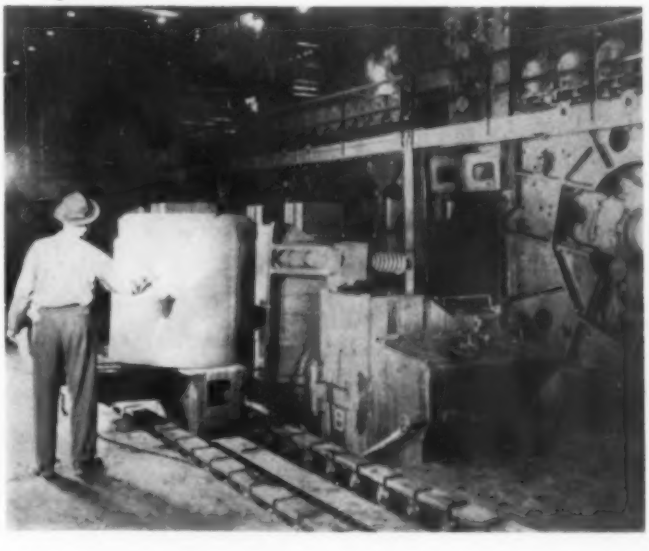


Figure 6 — The car type conveyor shown is designed to handle 48-in. diam coils of hot strip weighing 11,000 lb each at a rate of 90 coils per hr.

On a recent temper pass mill entry conveyor, a hydraulically operated unloader was developed to raise between the two chains, lifting the 76,000-lb coil to payoff reel (Figure 9). This operation provides accurate positioning of coils and avoids the impact that would have occurred had these semi-finished coils been rolled over conveyor end to conventional safety stop and hoisting cradle. At the same mill a unique coil buggy transfers coils from tension reel and loads them to a delivery conveyor.

Transferring coils on end between conveyors without damage has presented a difficult problem, yet is im-

Figure 7 — A coil is shown being transferred from a hot strip coiler to a waffle-top transfer on a conveyor system.



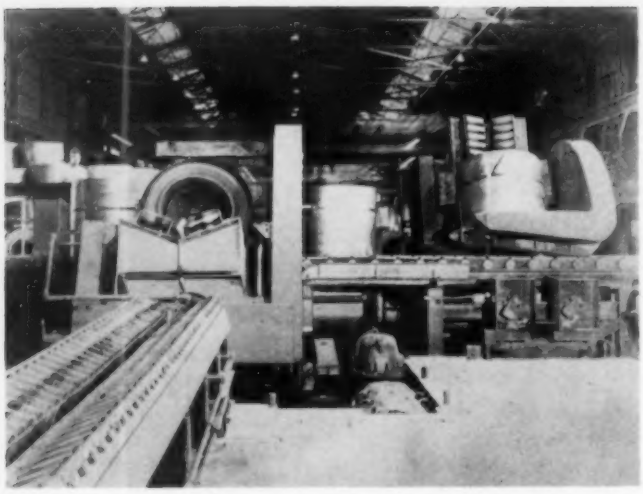
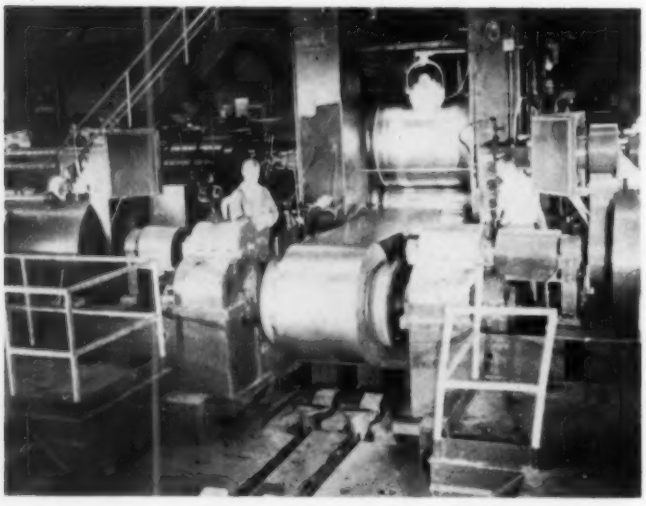


Figure 8 — Two side discharge down-tilters are used in this handling system for discharging hot strip coils at 90 degrees from a conveyor system to troughed gravity rolls. A 100-hp worm gear reducer drive is used on the down-tilter.

portant, for such transfers usually occur while the metal is still hot. Earlier designs of 90-degree transfers using live rolls were inadequate for they scuffed and peened the hot strip edges. Often, too, partially telescoped coils stalled on the rolls, causing delay and creating a safety hazard until removed. Recently, a hydraulically operated lift and turn unit was developed which reduced a 90-degree transfer to its simplest elements (Figure 10). Horizontal arms lift the coil from the chains of one conveyor, raise on a spindle, turn and lower coil to the next conveyor, without sliding or rolling. This transfer has proved most dependable and effective in preventing coil damage. In one case, it was used not only for a 90-degree turn, but delivered coils to a third conveyor by turning a full 180 degrees.

A most unusual problem required that coils be tilted on their sides during a transfer between conveyors on the same center line without rolling. The first conveyor was of the double strand type, but the second was a grid of rails with no space for clearing the tilter arms (Figure 11). This problem was solved most successfully

Figure 9 — A hydraulically-operated unloader between the two chains raises the coil to the payoff reel.



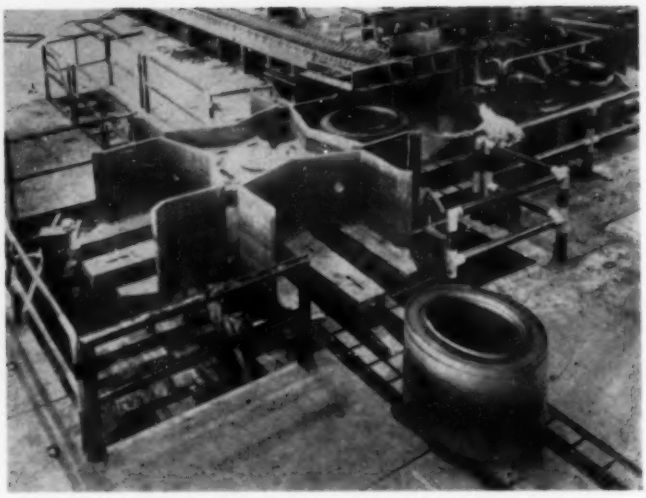


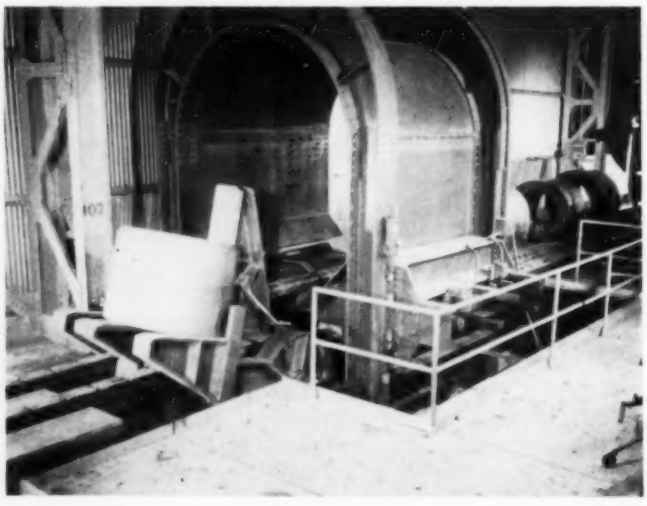
Figure 10 — The lift-and-turn unit can be used not only for transferring the coils 90 degrees but can also be used for a full 180-degree turn.

with an end tilter which lowered coils into a pair of retractable rollers, mounted on a transfer car. The car moves over grid top conveyor and the coil is lowered as the rollers retract. Space and the time cycle did not permit incorporating both units into one machine.

Naturally, the most important advance in transfer design would be a conveyor system which eliminated all transfers. The car type accomplishes this objective within the limits of its own travel. Another step in this direction was made by the application of the booster drive to coil conveyors. Essentially this is a short (about 10-ft centers) conveyor equipped with dogs which engage and propel the chains of main conveyor on any straight run without interfering with load being carried. Single conveyors of any length may be built by the addition of as many booster drives as are necessary to remain within the load limit of the main conveyor chains. This eliminates the necessity for a series of conveyors with objectionable transfers between. It has been used successfully for driving all three types of conveyors previously discussed.

It is important to note that the joint pins of the main chains do not turn in the links, while the propelling

Figure 11 — The unit shown in the photograph will transfer coils between conveyors on the same center lines at the same time tilting them on their sides.



force of the dogs is applied. Compared with sprocket driven conveyors where the chain pins turn under full load, this feature of the booster drive reduces joint wear to a minimum.

Drive units have been further improved by the use of fluid couplings and magnetic drives to cushion mechanical parts against shock loads, to limit overload stresses, and to eliminate the necessity for high starting current.

Other mechanical and electrical improvements have been incorporated to meet the requirements of handling larger, heavier coils more gently. Time does not permit a discussion of the many arrangements and flow sheets that have been developed to solve specific problems of tonnage, time and space. Each problem is different and requires special study.

The conveyor industry is eager to cooperate with engineering and operating personnel of the steel industry in meeting the challenge for better economy and better operating efficiency of your processes.

DISCUSSION

PRESENTED BY

C. F. SEYLER, Assistant Chief Engineer, Jones and Laughlin Steel Corp., Pittsburgh, Pa.

MARTIN J. ANDERSON, Director of Research, Mathews Conveyer Co., Ellwood City, Pa.

C. F. Seyler: Knowing the background there is only one thing I should like to point out at this time regarding the equipment at Aliquippa. I feel that the success of the operation has been due largely to the close cooperation of the operators and maintenance men together with the conveyor designers who worked out every detail from one end to the other. They considered operating conditions, the materials to be used, and the proper design of each part. This applies particularly to the pusher. It was designed so that it would handle the 30,000-lb coils as narrow as 18 in. wide and not push them off on the side. That was one of the many considerations to be kept in mind when working on the design.

I think that if similar consideration would be given to all our equipment there would probably be fewer delays and less maintenance difficulties.

It might be of interest to report that the operators have nothing but praise for the equipment at Aliquippa. The equipment has been in operation for two years, and perhaps in the next five years or so we may have something to offer, but right now it is doing a splendid job. It is performing in accordance with design requirements.

Martin J. Anderson: It is evident that there has been much development, and much improvement in the mechanical handling of coils.

I want to make a comment with reference to the ruggedness of conveyors. Back in 1937 when steel mill expansion was about at its highest, we were approached by a master mechanic of one of our mills on this subject of making conveyors more rugged. To his comments I said, "When your company asks for a quotation on equipment, they tell our representative that he had better sharpen his pencil."

He said, "I know that conveyors have been bought like that in the past, but in the future the production men, the shop men, are going to have more to say about it."

I think from that 1937 period on, it has become evident that the production men have had quite a lot to say in connection with conveying equipment, as just brought out by Mr. Seyler. In this particular job, they had very much to say about it.

When the strip mill process was started, the coils weighed perhaps 3500 to 4000 lb. Today hot mill coils can run over 25,000 lb, and cold mill coils run up to 75,000 lb. There has been a tremendous step in the weights to be handled.

During that period there has been some misapplication of coil handling equipment not only by conveyor people, but also by the mill people. Mills tried to use conveyors originally designed for lighter coils, and also they have dropped many coils on conveyors, and used the conveyors as backstops to straighten out a pair of coils before they could set them onto the conveyor line with a magnet. We all know that those things have happened, but as of today mill people are understanding that that is also a problem for the mill, and I want to bring out that it is a mutual problem, this matter of planning a conveyor or a conveyor system for a specific requirement. It is not only the conveyor man's problem but also the mill man's problem, and, when they work together, we will have less misapplication, we will have more successful systems, and we will have less abuse of conveyors in general.

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A MAGNETIC, REVERSING, PLUGGING CONTROL FOR CRANE BRIDGE SERVICE

By K. S. KUKA
Superintendent Electrical Engineering
and Construction
Tata Iron and Steel Co., Ltd.
Jamshedpur, India

. . . . the control modification described limits overspeeding and uses series brake control . . . .

▲ THE standard reversing, plugging magnetic controllers for crane service have indeed stood the tests of severe steel mill service. There are, however, certain difficulties in practice on long travel motions, which often create problems for a crane man in charge of crane operation and maintenance.

It is agreed that there is no uniform method of figuring the motor sizes and the gear ratios for crane bridge motors. *(Editor's Note: A procedure is now outlined in AISE Standard No. 6, "Specifications for Electric Overhead Traveling Cranes for Steel Mill Service".)* The motor frame sizes are selected on the basis of the full load speed and an assumed value of the "tractive effort." Due to various other problems, such as squareness of the crane bridge, alinement of the long travel shaft, meshing of the gearing and the alinement of the crane main runway tracks, it is always advisable to provide sufficient margin in the motor horse power. Besides the above considerations, if the motor is to be derated on the higher ambient temperature basis, the final frame size selected will be higher than the actual horse power requirements calculated on the basis of load, speed and tractive effort. It is always advisable to select the motor on a liberal basis, especially for bridge service and design the controller to suit the actual service conditions.

When the distance traveled is comparatively long, as in case of outdoor yard cranes, warehouse cranes and ore bridges, the over-motoring causes overspeeding at light hook loads. With the modern anti-friction or cartridge type bearings, the overspeeding on empty hook may be as high as 200 per cent of the full load speed. The overspeeds thus cause heavier shocks to the building structures, because the shocks vary as the square of the speed.

A mechanical braking device is also an essential feature of a crane bridge motion, as the motion must quickly be arrested when the power suddenly fails, and it also is necessary to arrest the sudden motion on outdoor cranes due to high winds in a gale.

On modern cranes, hydraulic brakes have been standardized for bridge motion, because of certain advantages in service, i.e., the brakes can be used to arrest motion only when an operator wishes to. However, a hydraulic brake demands greater and continuous maintenance if its effectiveness is to be maintained.

The best service brake is an electrically operated series brake which operates along with the motor. One great disadvantage of the series brake is that it drops out every time the control master switch is brought to the "off" position and does not allow coasting of the bridge when required. The sudden dropping of the brake, when the controller passes through the "off" position, causes a troublesome and often dangerous hook swing. On account of the above mentioned disadvantages, a series brake is normally not used on a crane bridge.

In this paper a circuit modification of the standard reversing plugging controller is proposed, which gives overspeeding limitation of the crane bridge motion at light loads, and at the same time gives controlled series brake operation, so that the brake is automatically delayed in dropping, allowing normal plugging duty as well as the coasting cycle of the motion.

Figure 1 gives the connection diagram of the controller. The scheme is the same as with any standard controller, except for the addition of the teaser field loop over the contactor TF, and the counter-emf relay, called cemf across the armature.

LIGHT HOOK OVERSPEED LIMITATION

The normal practice on standard controllers is to provide a teaser field circuit in the last notch of the master switch, giving a fixed minimum excitation to the

motor, limiting its maximum speed to a fixed value. The teaser field circuit is made irrespective of the load on the crane hook. The crane speed then with heavy loads will naturally be reduced lower than the normal specified.

In the controller described in Figure 1, the teaser field connection is made dependent on the hook load, so that for loads above a certain definite value, the teaser field contactor is automatically locked out.

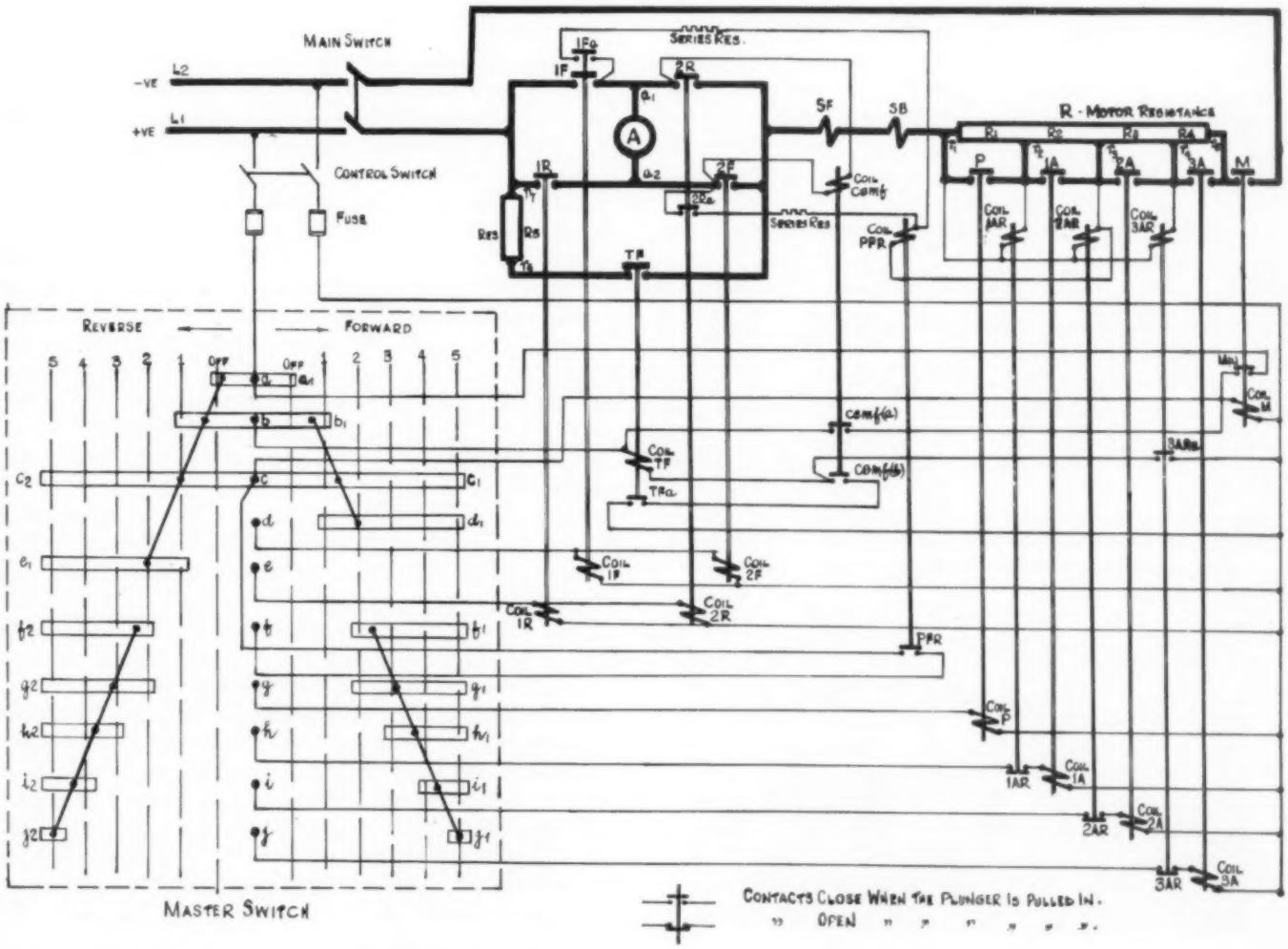
When the master switch is suddenly taken to its last notch in the usual manner, the crane moves in the normal way, accelerated smoothly by the accelerating relays 1AR and 2AR.

When the accelerating contactor 2A has gone in, the magnetic time relay 3AR is de-energized. The timing of the 3AR relay is adjusted to work in a fixed relationship with the cemf relay. The acceleration of the bridge at each step depends on the actual load on the hook. The acceleration of the bridge naturally depends on the back emf of the motor. The pulling in of the cemf relay therefore depends on the rate of acceleration of the crane bridge after 2A contactor has gone in. The settings of the cemf relay and 3AR relay are so adjusted that if cemf relay pulls in before 3AR relay drops out, the teaser field contactor TF pulls in and introduces the teaser field circuit. The cemf relay will go in earlier than the timing of 3AR relay for light loads on the hook, because the rate of acceleration will be much higher than with heavy loads. For heavier loads, 3AR relay will time out before cemf can pull in, so that TF fails to be energized, allowing the motor to work direct on line as a series motor at its normal full load speed. Thus, by comparing the rate of rise of the motor back emf with a certain fixed time interval, it is possible to control selectively the overspeeding of the bridge on light loads up to a predetermined value.

CONTROL OF THE SERIES BRAKE OPERATION

The TF contactor is also connected over normally closed contacts (3-4) of the master switch. These contacts remain closed up to the first notch in either direction. This permits coasting of the crane bridge, when the master switch is suddenly brought to the "off" position, because the contactor TF remains pulled in, allowing the brake to remain in the released position, though the motor armature is disconnected from the line. If the driver suddenly wants to plug the crane, he takes the master switch to the reversed position. Though the controller passes through the "off" position, the series brake is prevented from becoming de-

Figure 1 — Schematic diagram of connections showing reversing plugging control system.



energized. The control therefore behaves as if the series brake were not provided. When, however, the crane comes to a slow speed or standstill and the controller is brought to the "off" position, and left there, the series brake sets in after a short time, because both cemf and 3AR relays drop out. The operation of the series brake is thus so controlled that it permits smooth coasting as well as plugging operation without causing any disturbance.

ADVANTAGES OF THE SYSTEM

The main advantageous features of the proposed controller can be summed up as follows:

1. The fundamental features of the standard controller for reversing plugging service are retained without any changes.
2. Overspeeding limit of the long travel motion due to possible over-motoring is provided by adopting the standard idea of a teaser field circuit. However, the teaser field circuit is introduced dependent of hook load, i.e., only when the crane is running with light hook loads up to a preset value.
3. The well established and most effective series brake is retained for the bridge motion. The control prevents the series brake from dropping every time the master switch is moved over the "off" position during crane operation. This removes the fundamental drawbacks of a series brake on the long travel motion. There is no specific need to take resort to a more complicated hydraulic brake requiring greater attention and care.
4. The number of contactors and relays used is the same as in any other standard controller provided with teaser field circuit. The specific control circuit provided for the TF contactor is the original feature proposed which gives all the advantages claimed for the system.

NATIONAL TUBE BUILDS NEW POWER PLANT

▲ CONSTRUCTION is well underway on a large new boiler plant to supply steam for all type operations of the National works, McKeesport, of U. S. Steel's pipe-making subsidiary, National Tube Co. The structural steel framework for the new plant is going up and the unit is scheduled to start operating next spring.

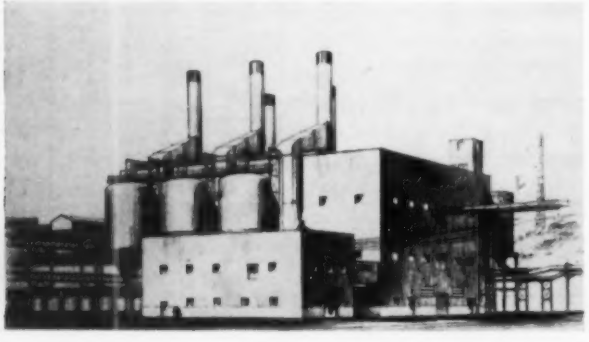
The improvement is another major project in the corporation's extensive building program in mines and plants extending from coast-to-coast.

The new facility at McKeesport will have five high-pressure boilers, each capable of furnishing 175,000 lb of steam per hour, or more than enough required to operate the big pipe plant at full capacity.

The new boilers replace 57 old low-pressure ones, all of which have been in service more than 40 years.

The project is the most extensive modernization move at the McKeesport plant since before the depression. It is the second major development undertaken there in recent months. The first announced is a new mill for the production of electric welded steel pipe. Construction is well along on the pipe mill, with start of operations scheduled for early spring.

Prominent on the skyline of National Tube Co.'s McKeesport plant will be the new power plant under construction.



The boiler plant will change the skyline of National works. Seven stories high, it will be the tallest structure there. An elevator will be installed to carry men and materials from floor to floor.

The plant will include a complete water treatment unit for processing Monongahela River water for use in the boilers. The unit will have a capacity for treatment of a million gallons of water every hour. In maximum use, the boiler plant will require 14,500,000 gal of water every 24 hrs, including 10,000,000 gal for cleaning blast furnace gas.

The principal fuel used in firing the new boilers will be washed gas from the plant's four blast furnaces. Pulverized coal will be used as auxiliary fuel when needed. An existing unloading tower along the river bank at the site of the new boiler house will be used to bring in coal from river barges.

Gas cleaning equipment of the newest design will be installed to reduce the amount of fly ash and smoke coming from the boiler plant's chimneys, and the fly ash will be further reduced through the use of dust collectors which will be installed in each of the five stacks. The gas cleaning facility will involve two operations. In the primary cleaning, the gas will be washed with water. The second move will be an electrostatic water cleaning process.

TURBO-BLOWER CONTROL

By H. ZIEBOLZ
Vice President
Askania Regulator Co.
Chicago, Ill.

. . . . a number of schemes have been developed to control blower operation . . . .

▲ THE purpose of a blower is to move a given amount of gas from a level of low pressure to one of higher pressure in a given time. Thus, one could state its function as a device which produces a negative pressure drop and hereby creates a flow against a higher pressure level. In accordance with the laws of conservation of energy, this means that energy has to be supplied to produce this pressure drop, and we find the following, therefore, used most frequently as prime movers for such blowers:

1. Turbines (gas or steam).
2. Motors.

Figure 1 shows the basic circuit of such an installation. It will be noted that the symbols for the turbine and the blower differ in that they are opposite hand pictures of each other, the smaller side of the figure indicating smaller volumes handled due to expansion or compression of steam or gas. This applies to the volume of steam as well as to that of gas.

In the chosen symbols it will also be noted that the circuit indicates differences in pressure levels by showing lines of higher pressure above those of lower pressure.

USE OF BLOWERS

In line with our definition of blowers, we find these units employed wherever a motion of gas from a level of lower pressure to one of higher pressure is required.

As constant pressure in general serves as an indication of a balance between supply and demand from a plant A to a plant B (Figure 2), the control of pressures P_1 or P_2 by varying the rate of flow of gases passing through the blower c establishes such a balance. The choice of the control point P_1 or P_2 appears to be arbitrary, but usually has to be made in accordance with other considerations dictated by the operation of the plant.

The important point to remember is that one cannot get both pressures constant as long as the demand of Plant B is not equal to that of the supply A. To permit short time discrepancies between the supply of A and the consumption of plants, it becomes necessary to add additional consumers or suppliers.

This is done either by:

1. Bleeding.
2. Adding storage capacity in the form of a gas holder.
3. Adding consumers.

On the supply side it calls for additional sources of gas which may be reduced to the pressure P_1 or boosted up to this pressure by additional blowers or compressors.

With a holder H (Figure 3) on the line, it is possible to maintain P_1 for short periods of time, in spite of variations between the supply of Plant A and the demand of Plant B by utilizing the holder capacity, i.e., its volume which is represented by its height s.

From the above it follows that restricting the motion of s to very narrow limits defeats the purpose of the holder and controls have to be provided which allow

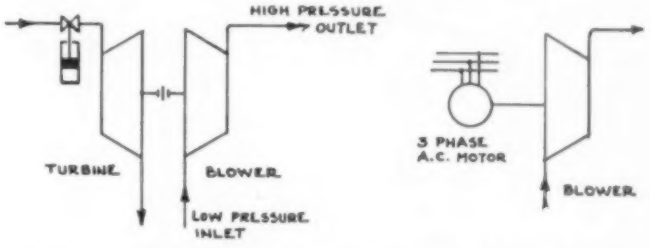
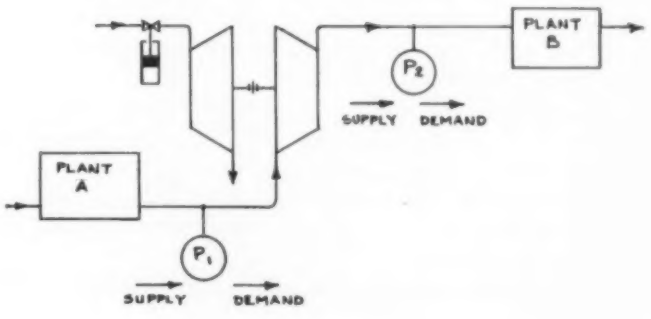


Figure 1 — Symbols used in drawings of blower circuits.

Figure 2 — Typical blower circuit.



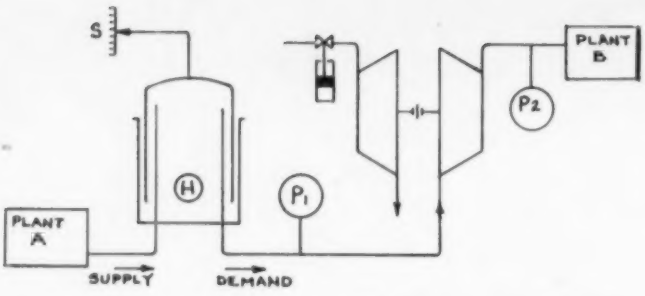
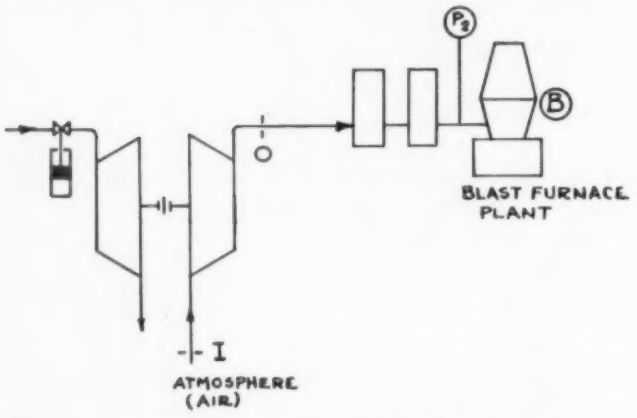


Figure 3 — A gas holder in the suction line gives storage which results in more uniform pressure as the demand varies.

Figure 4 — Typical blast furnace blower circuit.



the holder to move freely within a given range of heights, while limiting its supply and demand to protect it from overtravel.

This leads us to suction or inlet control of blowers as our first problem. A second problem is to provide controls to match demand and supply differences. This includes holder controls. Finally, there are problems in which the rate of flow through the blower has to be furnished to the furnace regardless of the resistance P_2 of the furnace B (Figure 4).

It appears at first that this flow can either be measured at the inlet I, Plant B, or at the outlet of the blower O. It is usually preferable, however, to measure in the inlet as the wider variations of temperature (and pressure) in the outlet call for correction of the differential pressures produced by orifices or venturis which are used for measuring the flow rate.

We shall now see how the choice between I and O is affected by the characteristic of the blowers.

CHARACTERISTICS OF BLOWERS

The full story of the behavior of blowers with fixed inlet vanes is given by the diagram which shows the relation between compression ratios or pressures and flow rates. See Figure 5.

As the diagram indicates, we find definite relationships for compression ratios P_2/P_1 and rate of flows Q for a given speed n_1, n_2 and n_3.

For constant speed blowers (for instance motor driven units), any one of the speed curves n_1, n_2, or n_3 could be valid.

For variable speed drives including steam turbines as prime movers, the control of the pressure P_2 is established by variation of the speed n (assuming constant inlet pressure P_1).

The problem peculiar to blower control is that two volumes Q_1 and Q_2 produce the same pressure P_2 for a given speed n.

The consequence of this peculiar blower characteristic is the phenomenon of "pumping" which makes it imperative to keep the rate of flow through the blower above the unstable "minimum volume curve," A–A_1 the so-called "pumping limit," which is established for a given blower by computation and verified by tests.

Without going into the mechanism of pumping more in detail, it will be instructive to visualize a blower supplying gas to a consumer which reduces its load from Q_1 to Q_2. See Figure 5.

Let us assume that the speed of the blower is constant and that its value is represented by the curve n_1 of Figure 5.

With the blower running at a load Q_1 we find the pressure ratio P_2/P_1 equal to that given by point C.

For the sake of simplicity we shall again assume P_1 to be constant and therefore think in terms of an outlet pressure P_2 as associated with Q_1.

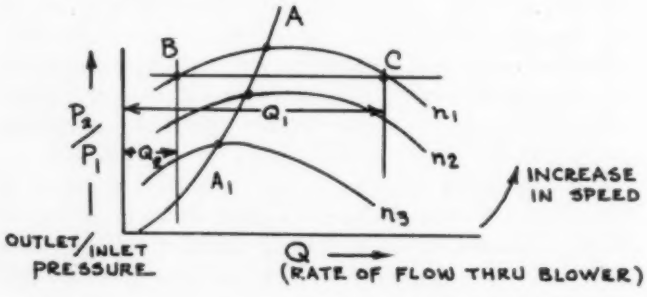
If the consumer load Q_1 now decreases and the speed remains the same, we note that the pressure P_2 produced by the blower increases until it reaches its maximum at a rate of flow corresponding to point A. This is the pressure with which at that time the whole pipe system leading to a consumer is charged.

If we now further decrease Q, it will be noticed that the pressure produced by the blower is less than that corresponding to point A, and as the result of this the blower cannot prevent the system which is charged with a higher pressure from discharging backwards through the blower, which actually reduces the flow Q not only to zero, but changes it to a flow in the opposite direction.

As a result of this, the consumer is robbed of its supply and the demand pumps back to a valve above A, charging the line with higher pressure and repeating this cycle. The major upset in flow rates is obviously not permissible and it is therefore impossible to run a blower with this type of characteristic left of the pumping limit curve A–A_1.

As the result of this, we have to consider the additional requirement that not only is it necessary to balance supply and demand, but also to prevent the load, i.e., the rate of flow of gas or air through the blower, from falling below the pumping limit A–A_1.

Figure 5 — It is a typical blower characteristic that there are two rates of flow for the same compression ratio, one of which is unstable.



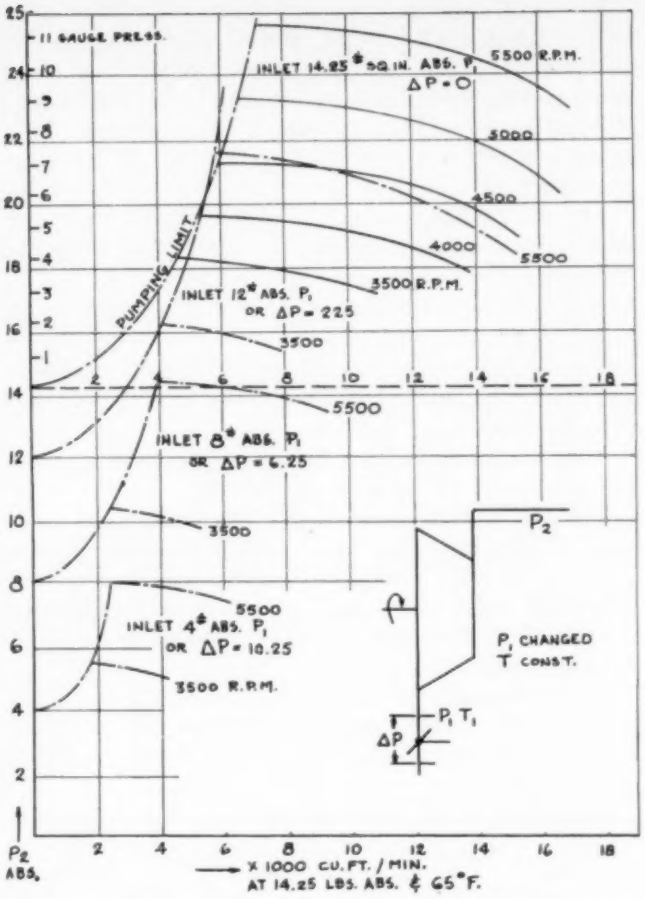


Figure 6 — Curves show how the pumping limit can be shifted.

Various means have been suggested to avoid the pumping or to reduce its interference by pushing the pumping limit further back to the left.

Lowering the inlet pressure by throttling somewhat helps, but decreases the outlet pressure at the same time (Figure 6).

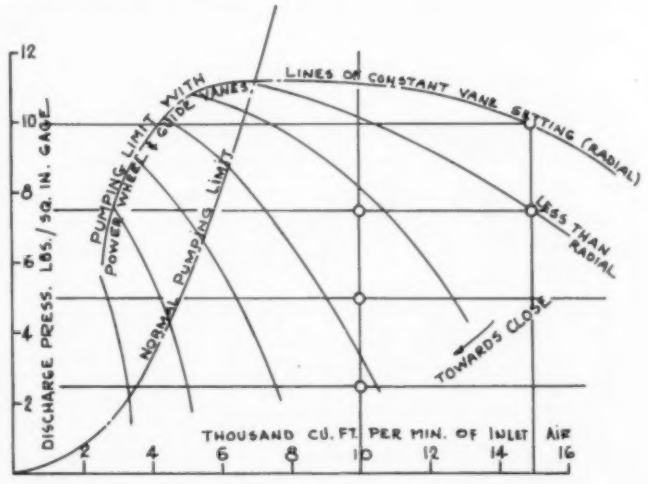
One company has developed a design which changes the pumping limit by a device which is built into the blower intake and called a power wheel. The effect of this design is shown in the characteristic of Figure 7.

Another manufacturer uses a design of variable diffuser blades which produces the characteristic of Figure 8.

As it is impossible to reduce the pumping limit to zero, the only solution for this operational problem is to increase the load Q (Figure 9) by bleeding either to the atmosphere or to the inlet (danger of overheating) whenever the load falls below the pumping limits.

From this diagram it follows that flow rates through the blower which affect the pumping should be measured at point A of total input, and that in measuring flow rates to the consumer B if measured at B, one has to take into account variations of temperatures and pressures at B which are a function of inlet conditions as well as of compression ratios P_2/P_1.

Figure 7 — A power wheel is used by one manufacturer to change the pumping limit.


LINES OF CONSTANT VANE SETTING (RADIAL)
PUMPING LIMIT WITH POWER WHEEL & GUIDE VANES
NORMAL PUMPING LIMIT
LESS THAN RADIAL
TOWARDS CLOSE
DISCHARGE PRESS. LBS./SQ. IN. GAGE
THOUSAND CU. FT. PER MIN. OF INLET AIR

CHARACTERISTICS OF BLOWER CONTROLS

With these data which describe the blower performance available, it is now possible to consider the type of regulators needed to control them. Most of the turbine blower controls of larger size are of the hydraulic type. A typical example is shown in Figure 10 which gives the circuit used in the control of the rate of flow going through a blower. The same basic unit can also be used for the control of pressure P_2-suction P_1, pressure difference P_2–P_1, power input to the blower, or its speed.

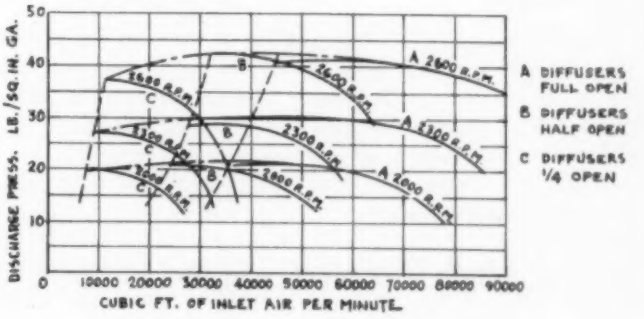
In order to obtain stable control performance, the mode of control employed, as shown in Figure 10, is "proportional plus reset." This means that the amount of valve adjustment is made directly proportional to the error, and the error is brought back to zero by a mechanism which slowly eliminates the error introduced by the proportional mode of operation.

Referring to the details of Figure 10 (1) is an orifice which measures the rate of gas flow or air flow entering into the blower, (2) represents a diaphragm which is balanced by a tension spring, (3). To this diaphragm, the flow differential is applied.

Any unbalance between the diaphragm force and the spring produces an error signal which moves the hydraulic jet relay (10) to the left or to the right, and hereby produces a pressure differential in the two receiving orifices which are located opposite to the jet relay nozzle.

As a piston acting as a positive displacement meter

Figure 8 — Operating characteristics of a blower operating with multiple diffuser blades.



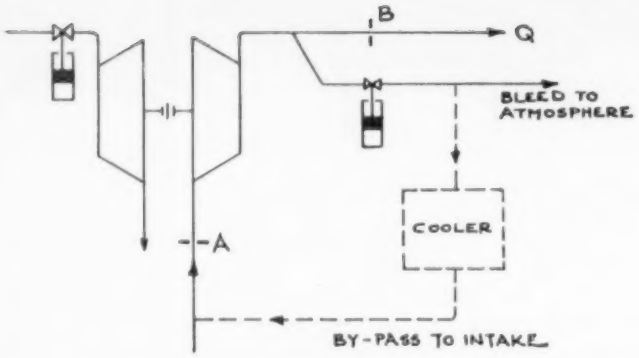
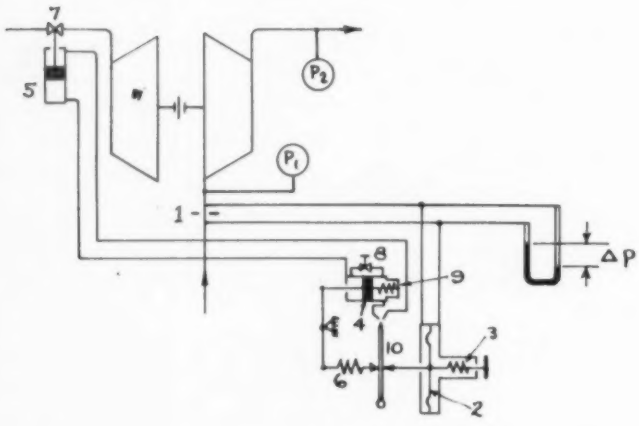


Figure 9 — Pumping can be prevented by bleeding or recirculating.

Figure 10 — Schematic diagram of a volume control for a turbo-blower.



(4) is inserted into one of the lines which connects these orifices to the double-acting cylinder (5), the displacements of (4) and (5) will become proportional, and as (4) is used to restore balance of the jet relay by changing the tension of spring (6) to compensate for the error, the steam valve (7), which is connected to the power piston, moves by an amount proportional to the error. Under the action of the restoring spring (9), piston (4) slowly resets the compensating spring (6) to its center position, as a bypass (8) is provided which permits the equalization of pressures on both sides of the piston (4) and hereby its gradual return to its own center ("reset" action.) The dynamics of such a regulator are too well known to need repetition at this point.*

The problem is somewhat complicated if more than one blower is operating on the same line. In such cases, it is necessary to use one master control and to distribute the load in a desired ratio between two or more prime movers.

To simplify the problem we shall assume that both blowers and turbines have identical characteristics. As shown in Figure 11, a master control of basically the same design as that of Figure 10 is used. To vary the circuit it is assumed that instead of controlling the inlet flow, the regulator is to control the pressure P_2 in the common outlet header.

*See S. P. Eckman, "Principles of Industrial Process Control," Wiley & Son.

It will be noted that instead of controlling the steam valves directly, a hydraulic pilot circuit is controlled by the piston (7) of Figure 11, and that the pressure P produced by the change of oil flow in the pilot line is applied to two mechanisms which produce proportional motion of valves (7a) and (7b) for a common loading pressure P.

Details of these pressure responsive devices are shown diagrammatically in the left lower corner of Figure 11.

As the master loading pressure P is applied to the diaphragm (9) which is balanced by spring (10), it displaces pilot valve (8) which in turn moves piston (11) until the spring tension of (11) establishes a new state of balance.

Thus a definite position of piston (11) is established for every value of loading pressure P.

The choice of a pressure control problem for the purpose of illustration was also made for another reason. It will serve to outline another difficulty which is typical in such applications, i.e., the need to match blowers with non-identical characteristics. A glance at Figure 12 will indicate the problem.

Let us assume that n_1–a and n_1–b are the respective speeds of blowers (1) produced by two values P_a and P_b of the master-loading pressures, and n_2–a and n_2–b are the corresponding speed curves of blower (2).

Let us assume furthermore that P_0 is the desired line

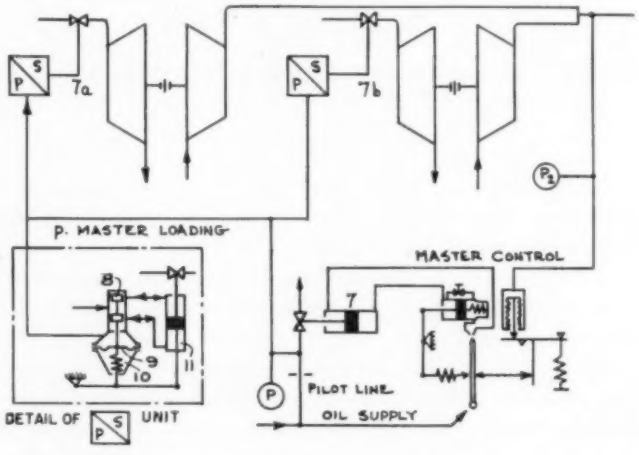
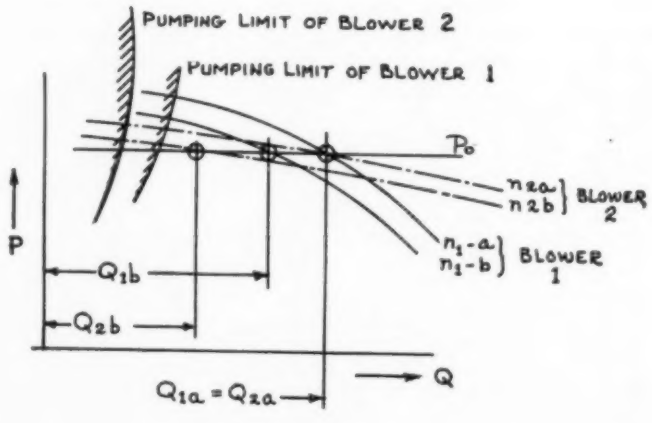


Figure 11 — Pressure control of parallel operating blowers.

Figure 12 — It is more difficult to set up a control scheme for parallel operation of two blowers with dissimilar characteristics.



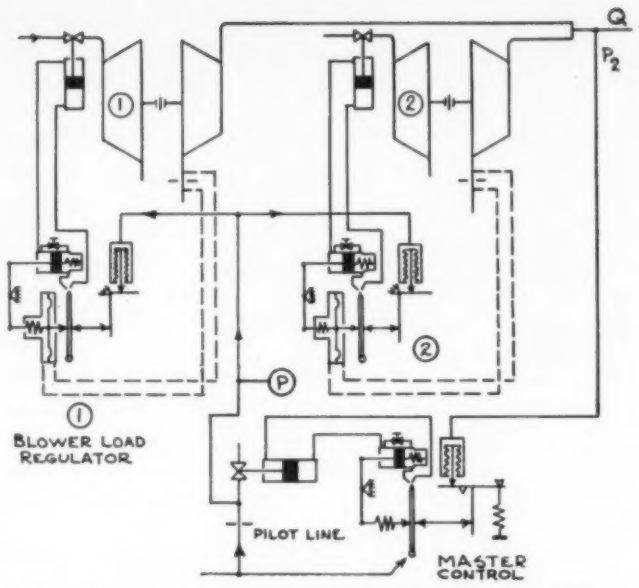
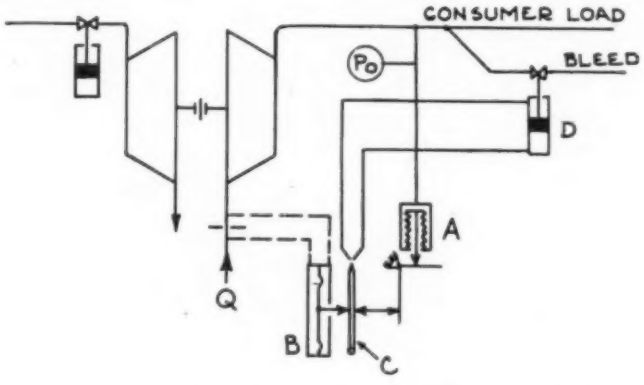


Figure 13 — Regulators shown are used for load distribution of two parallel blowers with dissimilar characteristics.

Figure 14 — Schematic diagram of governor used to prevent pumping.



pressure and that at load Q_1–a, by suitable design of linkages, we succeeded in having the same load Q_1–a on both blowers which are running at speeds n_1–a and n_2–a, respectively.

It will be noted that for the new speeds n_1–b and n_2–b which are the results of a change in the master-loading pressure, our new volumes Q_1–b and Q_2–b now differ. In other words, the distribution of load does not remain the same at various speeds. In extreme cases this can mean that one of the blowers slips back into the pumping range or that one of the blowers is overloaded.

To force both blowers to maintain proportional shares of the load various schemes can be used. The obvious ones are to have the master regulator not control the steam valve position, but to control:

1. The steam flow rates to the turbines in a given ratio.
2. The horsepower input (electrical or other prime movers) into the blowers in a given ratio.
3. The amount of flow handled by each blower in a given ratio.

The method mentioned under paragraph 3 above is illustrated in Figure 13. For the sake of simplicity, only two blowers are shown, as additional ones would be identical in layout.

As shown in the diagram, the master pressure P is applied to two volume regulators (1) and (2) and as volume times delivery pressure means horsepower input, the circuit enforces at all times proportional load distribution regardless of blower, valve characteristic or prime mover design.

ANTI-PUMPING GOVERNOR

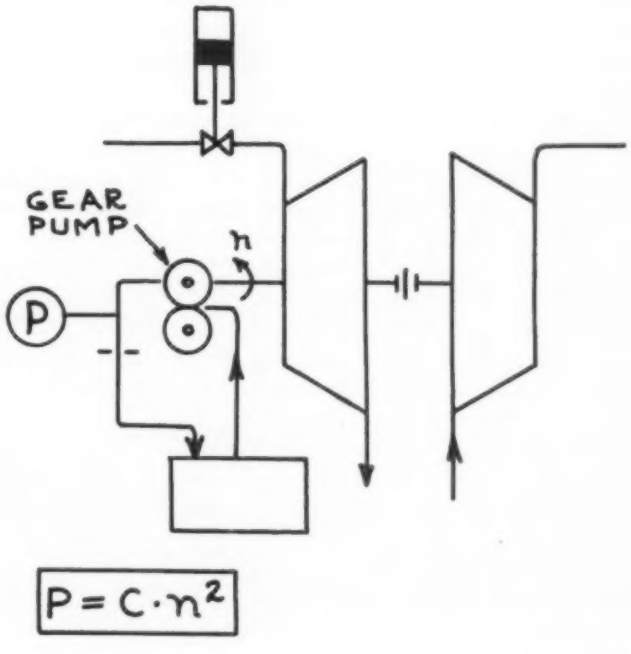
Another problem we are faced with is to avoid the "pumping" of blowers which was explained above in connection with Figure 5. For this purpose an "anti-pumping governor" has to be added to the blower control circuit.

We shall assume that the type of blower we want to control has again a turbine prime mover and that there are definite pumping points for every speed. (See Figure 5, curve A–A_1.)

A closer analysis of curve A–A_1 establishes the fact that it practically coincides with a parabolic function through the zero origin and the maximum pumping points. This makes it possible to build a regulator which closes a bleed-valve D as long as the volume Q is lower than the square of the pressure P_0, and opens it until P_0 is equal to the square of Q.

The anti-pumping governor shown in Figure 14 provides a pressure responsive bellows system A in opposition to a flow responsive diaphragm B. As the flow signal varies with the second power of the rate of flow Q and the pressure signal is directly proportional to the pressure P_0, the jet relay will be turned clockwise and hereby keep the blow-off valve D, in a blow-off branch to the atmosphere, shut as long as the signal from Q is greater than the pressure signal, i.e., the consumer is operating above the pumping limit A–A_1.

Figure 15 — The gear pump which is driven by a turbine produces pressure as a function of the speed.



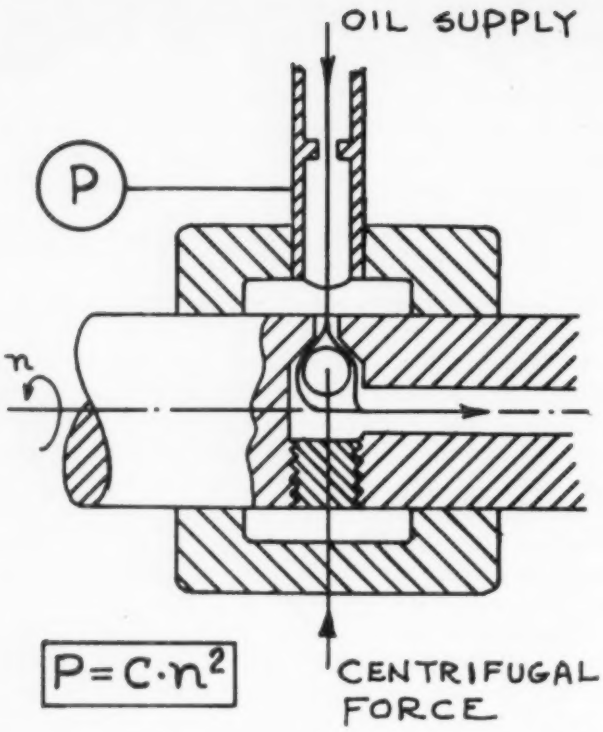


Figure 16 — In this design, the centrifugal force of the ball is balanced against fluid pressure.

As soon as Q tends, however, to drop below the pumping limit, the pressure bellows moves the jet pipe counter-clockwise and opens the bleed valve D as much as necessary to bring the volume which goes through the turbine up to the critical pumping valve A–A_1 of our original characteristic curve, Figure 5.

Due to the balance of the second power signal derived from the flow and the first power signal representing pressure, the regulator automatically keeps the consumer above the pumping limit curve.

As in all such applications there are cases which call for additional precautions. For instance, in the case of constant speed blowers, the line pressure is frequently controlled by means of a throttle valve in the inlet to the blower. If at the same time an anti-pumping governor is provided to maintain a minimum volume which has to pass through the blower, it can happen that due to high pressure in the delivery line, the pressure control throttles the intake while the anti-pumping governor tries to open the bleed-valve to increase the blower load. This can produce an unstable condition which can be avoided by providing a control circuit which first controls the pressure in the outlet by throttling the inlet volume down to the danger point, which then holds this volume constant, and continues to control the outlet pressure by bleeding the pressure header. In other words, in such a circuit, the pressure bleed-off valve is used to control the pressure and the inlet throttle valve to maintain a minimum volume.

SPEED AND PLANT CONTROL

Frequently the optimum economical operation of a number of blowers or of single units or safety considerations demand speed controls of blowers which either are to maintain a desired number of revolutions per time unit, or vary these as a function of another variable, or protect the blower and the prime mover against overspeed and possible damage.

The speed control problem is at once reduced to a pressure control problem by using a hydraulic pressure signal which is a function of speed. The simplest method used for this purpose is to provide a positive displacement type fluid delivery pump which is driven by the shaft of the prime mover and produces a pressure which is the square of its speed by forcing the fluid through an orifice (Figure 15).

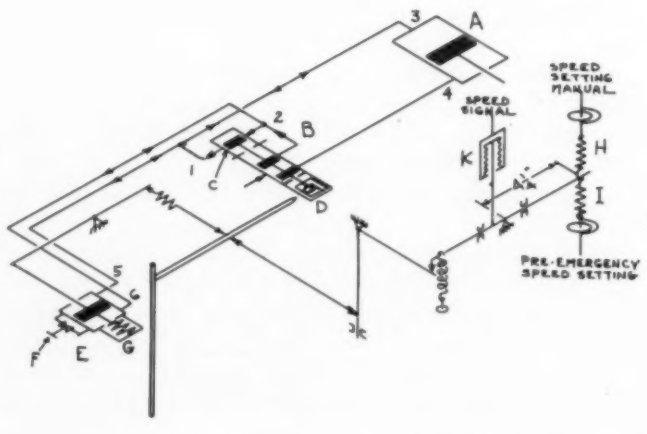
The disadvantage of this scheme is that due to temperature and viscosity changes of the fluid the obtained pressure is not a definite and repeatable function of the speed. Automatic compensating devices have been proposed and are used which vary the outlet orifice as a function of temperature.

More refined is the simple solution developed by one company, which balances the centrifugal force acting on a steel ball by means of a fluid pressure which thus becomes independent of the fluid constants. Figure 16 shows the basic principle of this speed pressure translator. A pressure control which is used to respond to this fluid pressure maintains the speed constant as every pressure represents a definite speed value.

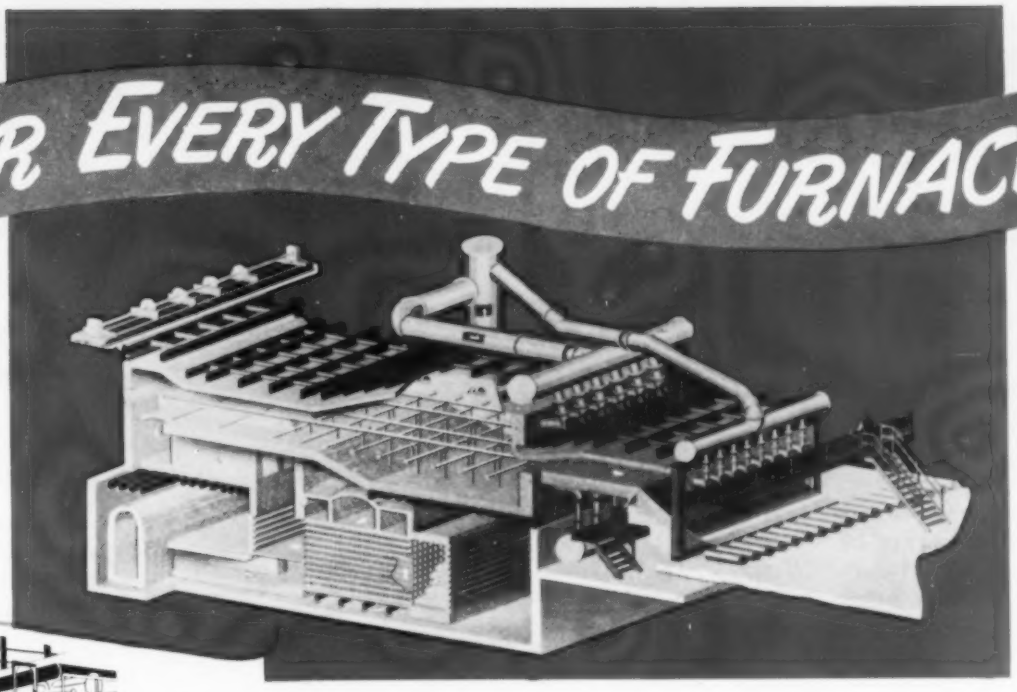
Figure 17 shows a basic speed governor used for this purpose. Two features of this controller call for additional explanation. First of all, the volume of the cylinder which controls the main steam valves is in this particular case so great that a direct control with the previously mentioned jet relay would result in too slow operation.

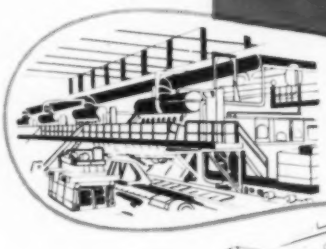
To handle larger quantities of oil flow, an auxiliary piston B has been added which is similar to the conventional four-way valve admitting oil to or relieving it from either side of a double-acting piston. To overcome the unavoidable dynamic unbalance of this auxiliary piston and to prevent it from being transmitted to the signal system or even to the jet relay, this piston is moved in turn by a small double-acting piston D which follows all movements of the jet relay as if it were mechanically attached to it. However, the actual coupling between the jet nozzle and this piston is accomplished through the action of the hydraulic fluid which,

Figure 17 — Basic unit for turbine controls.

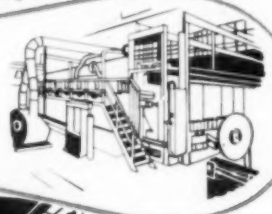


FOR EVERY TYPE OF FURNACE

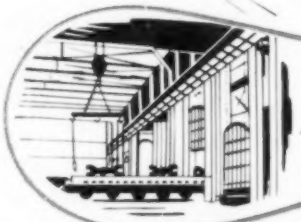




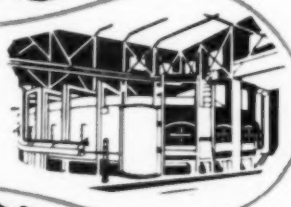
SLAB, BLOOM, BILLET, BAR HEATING FURNACES



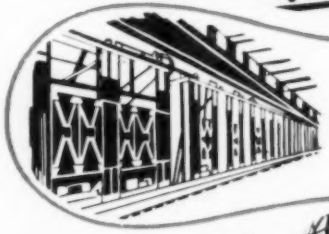
CONTINUOUS PIPE ANNEALING FURNACES



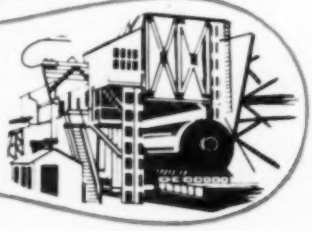
CAR BOTTOM TYPE HEAT TREATING FURNACES



ROTARY HEARTH, BLOOM AND BILLET HEATING FURNACES



BOX ANNEALING FURNACES



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leaving the jet nozzle under high velocity, hits between two opposing orifices which are part of the movable piston *D*. As these nozzles are cross-wise connected with either side of piston *D*, any relative displacement between the jet and the receiving nozzles immediately results in a motion of *D* which returns the center between both receiving nozzles again into register with the jet nozzle.

The variable orifice *C* which is directly connected to the auxiliary piston *B* is so arranged in one of the lines (2-1-3) which is leading to cylinder *A*, that it produces a pressure drop in this line across the orifice *C* which is a function of the rate of travel of the piston in *A*.

The resulting differential pressure which (contrary to that across a fixed restriction) does not follow the usual second power law but a more desirable function produced by the shape of orifice *C* is applied to both sides (5) and (6) of the stabilizing piston with which we are familiar from Figure 10.

Under the action of this differential pressure, the stabilizer piston moves at a rate which is proportional

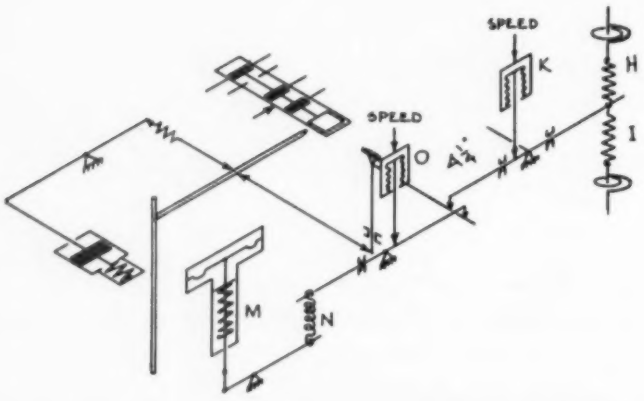


Figure 18 — A secondary system is used in the turbine control which is here illustrated.

to the rate of travel of the main control piston *A*. Thus, after a given time interval, we find again as in the case of Figure 10 a motion of the stabilizer which is proportional to that of the main control cylinder and thus produces the proportional mode of control previously explained.

Again, as in the case of the simpler circuit of Figure 10, the stabilizer piston *E* of Figure 17 is forced to return to its center position due to the action of spring (6) which gradually forces oil through the bypass *E* ("reset" mode of control). It will be furthermore noted that two springs *H* and *I* are used for the setting of the regulator. *I* is used as the pre-emergency setting device and is only accessible after removing the cover plates from the regulator. Any changing of the setting of *H* of the regulator can only reduce but never increase this maximum permissible speed, as the force of spring *H* deducts from the force of spring *I*.

If this regulator is to be used with a conventional air-operated controller, which, for example, responds to temperature, a secondary system *M*, Figure 18, with or without valve positioner, is added, which in turn controls the speed of the turbine as the stroke of the valve *M* adjusts a spring *N* which opposes the speed signal

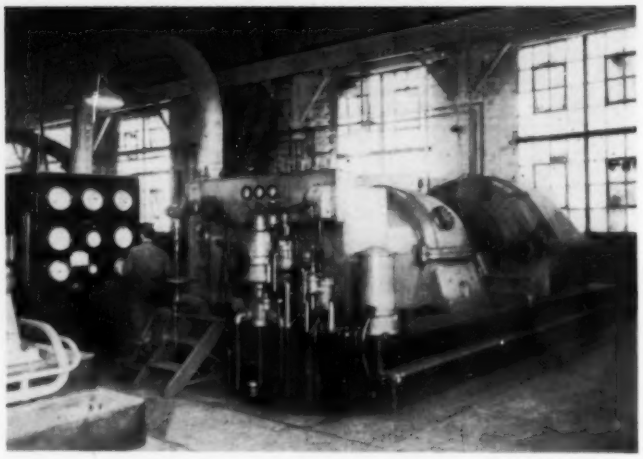


Figure 19 — The 60,000 cfm blast furnace blower unit in the photograph has an air weight control which changes the turbine speed through a connection to the turbine governor mechanism.

applied to a bellows *O*. This speed signal is the same as that applied to *K*.

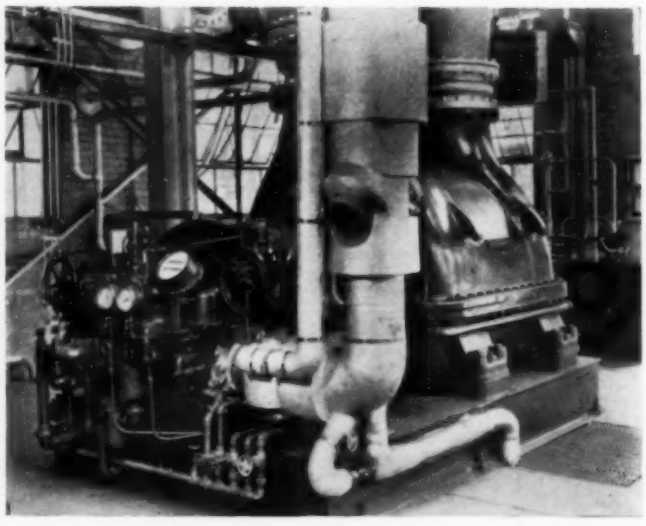
Under action of the pneumatic controller (not shown) the turbine speed is adjusted by the control valve *M*.

If for any reason, however, the speed should reach a predetermined maximum value established by the setting of springs *I* and *H*, the right-hand pre-emergency governor will cut in and take the control away from the left-hand temperature controller.

Again, there are many variations of this theme and special circuits responding to current-wattage flow, etc., have been designed to meet various specifications. As they do not offer any basically new principles, they would go beyond the scope of this paper.

In closing, it appears desirable to stress the need for closest cooperation between the designers of the turbine, and of the blower, the designer of the control, and last but not least, the man for whom all the above are producing their machinery or devices, the operating man whose economic balance sheet, time and cost of maintenance and ease of operation—if not his personal and plant's safety, are all the end result of such a co-operative effort.

Figure 20 — This turbine driven multi-stage blower is used as a coke exhauster.



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EXPERIMENTAL OPERATION OF A BASIC-LINED SURFACE-BLOWN HEARTH FOR STEEL PRODUCTION*

By C. E. SIMS
Assistant Director
Battelle Memorial Institute
Columbus, Ohio

and

F. L. TOY
Assistant to Manager, Research and Development
Carnegie-Illinois Steel Corp.
Pittsburgh, Pa.

▲ Thirty-two heats of new "special process" steel have been made by surface-blowing 1000-lb charges of hot basic iron in a basic-lined hearth. The experiments were conducted in a cooperative research project of Carnegie-Illinois Steel Corp. and Battelle Memorial Institute.

Conclusions from the research project are as follows:

1. Surface blowing in a basic-lined hearth to produce steel from basic iron is chemically sound and metallurgically feasible.

2. Mechanical properties of the steels produced place them in the same limits as open hearth steel of the same composition.

3. Standard basic pig iron is entirely suitable as a raw material.

4. Average time of heat was 12 minutes. The time was demonstrated to be a function of the rate of air input, or of oxygen input when oxygen-enriched air was used.

5. Abrupt carbon flame drop was an accurate indication that the carbon content was close to 0.05 per cent.

6. Carbon can be oxidized to below 0.03 per cent, manganese below 0.01 per cent, and silicon below 0.01 per cent.

7. Nitrogen can be maintained at about 0.003 per cent.

8. Up to 97 per cent of the phosphorus and up to 50 per cent of the sulphur can be eliminated.

9. A substantial part of the temperature gain in the process was found to be from the oxidation of about half the carbon to CO_2.

10. Burned lime requirements were from 120 to 180 lb per ton.

11. The fumes produced were definitely less dense than in the acid bessemer process. In the course of the experiments slopping was controlled until it was no further problem.

During the experimental program, some of the heats were raised in carbon, manganese and silicon by the addition of carbon and of ferro alloys, and deoxidized by aluminum to produce ingots of semi-killed plate and structural grade. The one-half-inch test pieces which were processed from two of these ingots are designated in the following text as Special Process No. 1 and Special Process No. 2. The mechanical properties of these test pieces were compared with those of specimens from plates processed from a representative bessemer blow and a representative open hearth heat. In selecting the material, the composition, particularly with respect to carbon and manganese, was specified to permit a comparison at approximately the same strength level after normalizing. Because the subject steels from the three processes were reduced to ½-in. thick plates by methods which were not identical, it was not feasible to control the finishing temperatures in the range desired. Hence, all of the materials were normalized for one hour at 1700 F before testing.

The specimens used for making tensile tests had reduced sections, ½ by ½ by 2¼ in. long, and gage lengths of 2 in. This specimen size was adopted so that the existing extensometer equipment could be utilized; consequently, the per cent elongation is reported in a 2-in. gage length.

TABLE I

COMPOSITION OF PLATE USED FOR COMPARISON OF BESSEMER, OPEN HEARTH, AND SPECIAL PROCESS STEELS

Type	Heat No.	Composition, per cent							
		C	Mn	P	S	Si	Al	Al_2O_3	N
Bessemer	Y-4836	0.15	0.45	0.097	0.038	0.017	0.006	0.005	0.008
Special Process No. 1	4017, Heat 23	0.18	0.68	0.027	0.019	0.102	0.005	0.020	0.002
Special Process No. 2	4605, Heat 32	0.26	0.52	0.022	0.024	0.086	0.007	0.013	0.003
Open Hearth	72L083	0.26	0.47	0.014	0.034	0.075	0.006	0.009	0.003

* Condensation of a paper presented at the annual meeting of the American Institute of Mining and Metallurgical Engineers, New York, February 12-16, 1950.

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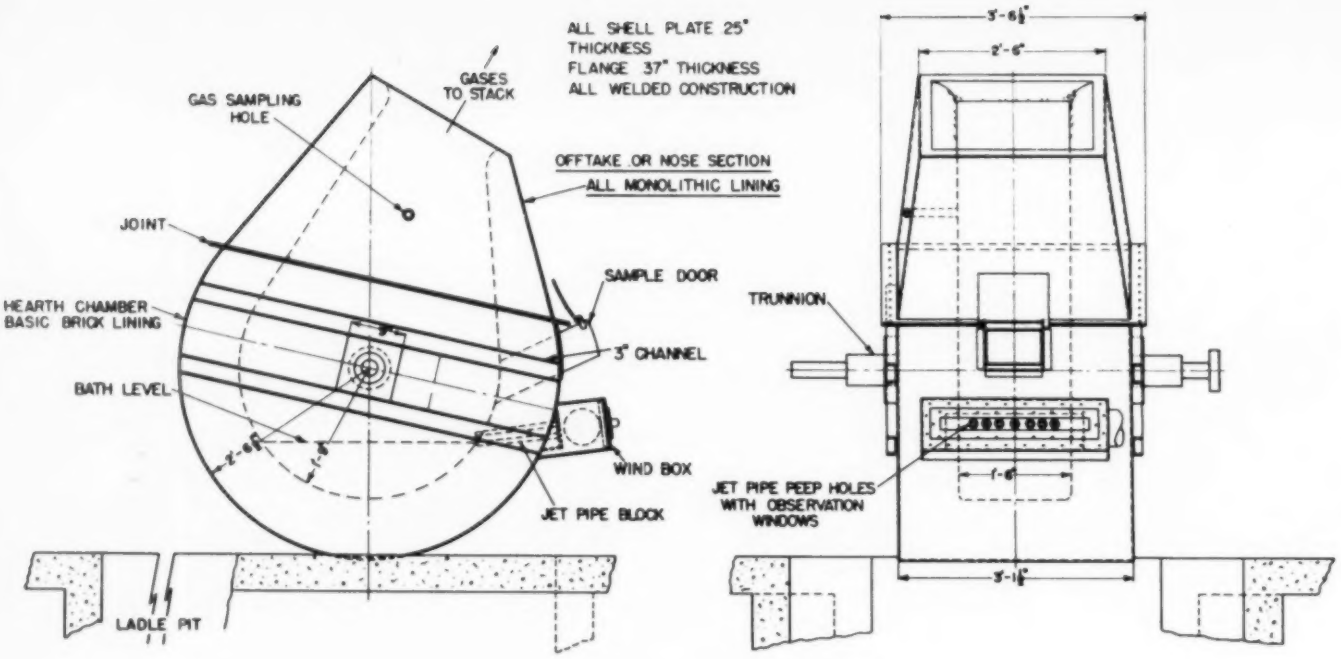


Figure 1 — Experimental hearth chamber for surface blowing.

The chemical compositions of test specimens in per cent as obtained by check analyses appear in Table I.

The usual bend tests were made on 1½-in. wide specimens of full plate thickness. All of these specimens not only bent the required 180 degrees over a diameter equal to the plate thickness, but could also be bent flat without rupture.

In addition to the usual tensile testing reported in Table II, additional test specimens of each of the four steels were tensile strained 10 per cent after which aging treatments of 10 minutes at room temperature, 24 hours at room temperature, and 3 hours at 400 F were applied. The specimens were then put back in the tensile machine and tested to failure. By comparing the results of this testing with those obtained in the customary tensile test, it was possible to evaluate the effect of the above aging treatments, after 10 per cent straining, on the increase in true stress at 10 per cent strain, and the increase in tensile strength and the loss in uniform elongation, total elongation and reduction in area. The data obtained showed that the two special process heats performed similarly to the open hearth heat and both steels performed differently from the bessemer steel. The same differences were brought out by hardness tests conducted before and after both straining and strain aging.

Another more commonly used test for determining strain aging was tried on the steels tested. This is the familiar concrete-bar test in which test specimens are bent 90 degrees, aged at 550 F for 1 hr and unbent. In this test, the bessemer steel fractured with practically no deformation on unbending, whereas specimens of the two special process steels and the open hearth steel unbent to a flat position without developing cracks.

Transition temperatures were determined on all of the materials in the normalized condition using Charpy keyhole notch bar impact specimens. It was found that the special process steels were comparable to the open hearth steel and had lower transition temperatures than the bessemer steel.

Charpy notch-bar impact tests were also conducted on these materials in both the strained and strain-aged conditions. The results indicated that the effect of both straining and strain aging are greatest in the bessemer steel, and that the special process steels are much more like the open hearth steel in this respect.

One method sometimes used to evaluate strain aging is to compare the tensile strength at room temperature with that at approximately 400 F. Materials showing a gain in tensile strengths at 400 F are said to be susceptible to strain aging, and the degree of strain aging is judged by this increase. The strain-aging propensity of the two special process steels in this test is comparable with that of the open hearth steel.

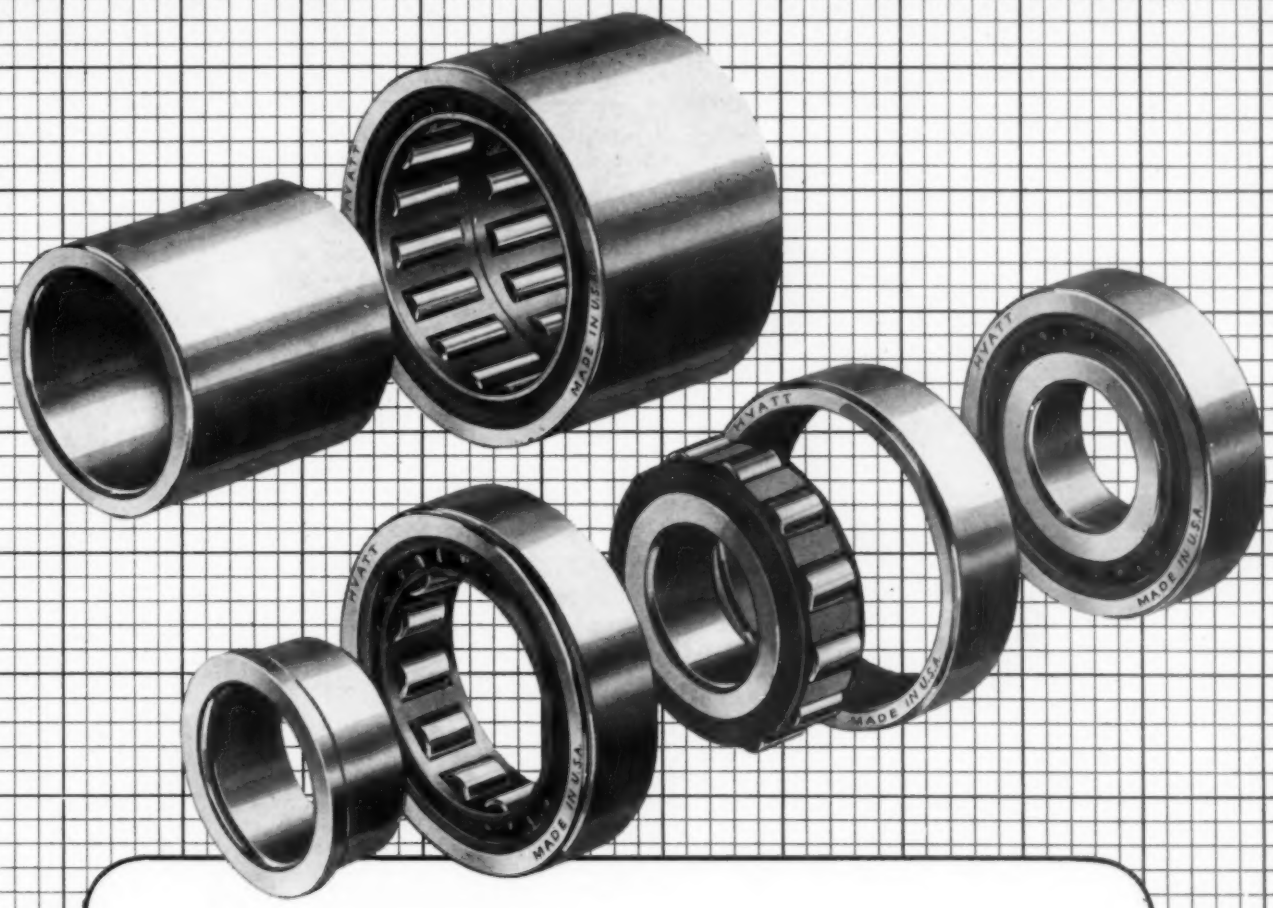
Heats made later at South works by the special process, cast as ingots and rolled into plates were subjected

(*Please turn to page 120*)

TABLE II

LONGITUDINAL TENSILE RESULTS ON MATERIALS NORMALIZED AT 1700F FOR ONE HOUR

Tensile Properties	Bessemer	Special Process No. 1	Special Process No. 2	Open hearth
Upper yield, psi	41,850	35,450	36,550	36,300
Tensile strength, psi	61,050	60,450	66,850	64,550
Elongation in 2 in., per cent	37.5	35.7	35.2	37.5
Reduction in area, per cent	64.7	56.8	57.7	61.6



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HYATT ROLLER BEARINGS

(*Continued from page 118*)

to a number of the above tests (ordinary and extraordinary) to determine whether the properties differed from those of open hearth steels. It should be realized that the compositions were such as to give "as-rolled" tensile strength ranging from 45,000 to 49,000 psi, so that a direct comparison with the properties of the Battelle heats could not be made. However, the customary tests indicated that the tensile and bending properties of the South works special process steels were equivalent to normal open hearth steel properties for a similar composition. In addition, the reverse bend tests indicated clearly that the material performed as well as open hearth steel. The Charpy transition temperatures were favorable and the amount of strain aging exhibited in the Charpy tests was approximately the same as that previously exhibited by the Battelle heats. It was, therefore, concluded that this special process material behaves in a like manner to open hearth steel of similar composition.

The experimental unit of 1000-lb hearth capacity was decided upon because it was considered that this was about the smallest quantity of iron that could be blown to advantage and the largest that could be melted conveniently in the laboratory.

In designing the unit, efforts were made to keep it as simple yet as flexible as possible to obtain maximum experimental data. The main dimensions and principal details of construction of the shell are shown in Figure 1. The shell was made in two parts, the nose or offtake section being separate. The lower section, or hearth chamber section, is a short cylinder with axis horizontal and a segment cut off at the top where the nose section is attached. The nose section is a truncated pyramid designed to carry away the gaseous products of reaction.

This design provided a fairly shallow bath, with a maximum depth of 9 in., and a large surface area, approximately 18 by 36 in. The blast traveled the long dimension of the bath surface to give the maximum opportunity for reaction. Thus, it came close to simulating conditions that would pertain to larger hearths. By making the hearth chamber proportionately twice as wide, the capacity could be increased to more than 27 tons by increasing the diameter three times.

The lower section or hearth chamber, with the exception of the jet-block area, was lined with hard-burned magnesite brick laid in magnesite mortar. The nose section was made with rows of welded studs inside. An internal, removable form was inserted, and a periclase ramming mix tamped into place to form a monolithic lining. The two parts of the shell were lined separately and then assembled.

The seven jet pipes were placed in a single row and threaded into a base plate like a row of candle molds. The back plate of the wind-box was provided with a row of pyrex windows arranged so that the operator could sight down each pipe.

The complete unit was mounted over a pit large enough to allow the unit to turn over completely. This pit also contained a slag box and a ladle for receiving the finished metal.

The most satisfactory method tried for sampling the bath during a heat was to make an opening through the shell above the wind-box big enough, and at such an angle, that a regular sampling spoon could be dipped in and withdrawn with a sample of metal. Satisfactory slag samples were not obtained when the blast was on. Samples of charge metal were taken before it was put into the hearth, and samples of finished metal and slag were obtained when the hearth was tilted for pouring. Almost every sample of metal and slag was analyzed by two laboratories, and in most cases excellent checks were obtained. Gas samples were taken through a hole in the side wall of the nose section.

Temperatures were determined with an optical pyrometer. Readings on the pig iron were taken as it poured over the spout of the induction furnace used for melting or over the lip of the ladle into the hearth chamber. Temperatures of finished metal were taken as it poured over the lip of the nose section into the ladle. Temperatures during the heat were taken by sighting through a window and down one pipe.

It is quite appropriate to compare the surface blowing operation with the bottom-blown basic or Thomas process. While the elimination of silicon, manganese and carbon is similar in the two processes, the course of phosphorus elimination is significantly different. In basic bottom-blowing converter practice, no important quantity of phosphorus is removed up to the flame drop; the afterblow is necessary to remove this element. In the new surface-blowing process, however, all the phosphorus that is going to be eliminated is out by the time the flame drops.

Although the strongly oxidizing conditions that exist during the surface blowing operation would not ordinarily be considered ideal for sulphur removal, it has come to be well known that a slag, if sufficiently basic, will remove sulphur from steel even under oxidizing conditions. In the present tests, the sulphur of the pig iron averaged 0.035 per cent and that of the finished metal of all the heats averaged 0.021 per cent, with a maximum of 0.028 and a minimum of 0.011 per cent. Most of the sulphur eliminated was removed in the first four minutes of the heat, but there was a gradual reduction up to the end of the heats.

Compared with bessemer and Tropenas processes, the fumes given off during the blowing period of the new process were relatively small in volume. None were visible in the atmosphere of the laboratory building where the tests were conducted, the air remaining clear at all times. Observations of the stack showed that some brown fumes were emitted for 2 to 3 minutes at the start of blowing (probably manganese oxide), but only a thin white fume was produced for the remainder of the heat.

Commercial-scale experiments were conducted at the South works plant of Carnegie-Illinois Steel Corp. This work was done in a hearth designed and built by Jones & Laughlin Steel Corp., where it had been tested with an acid lining. Basic lining was installed at South works and fifteen experimental heats were made with charges of 25 and 30 tons of hot metal using fixed jets to surface-blow the metal.

Many operating problems remain to be worked out before smooth practice can be established, but these commercial-scale tests completely corroborated the results of the laboratory tests as far as the chemical reactions of the surface-blowing process is concerned.

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ALAN WOOD PUTS HOT STRIP MILL IN OPERATION

▲ The recent completion of a 30-in. continuous hot strip mill has given the Alan Wood Steel Co. greatly expanded capacity for the production of finished material, and particularly for flat-rolled products. Prior to this installation, the company's primary producing facilities exceeded the capacity of its finishing mills, necessitating the sale of a considerable portion of its production in semi-finished form. The new installation at Ivy Rock, Pa., which constituted a $9,000,000 project, will put the company in a much improved position.

Actually, the mill is not entirely new, but was rebuilt from an existing installation at the Cleveland, Ohio, works of Jones and Laughlin Steel Corp. The new building which houses the mill is 1100 ft long x 170 ft wide, and is constructed as two bays, parallel and adjacent. Construction of the building required 1500 tons of steel. Foundations for the building and equipment entailed 17,500 cu yd of concrete, and 150,000 cu yd of excavation and grading were necessary.

The mill is rated at an overall capacity of 218,000 tons per year, and is designed to produce hot-rolled strip over a range from 6 to 16 in. wide, 0.059 to 0.0746 in. thick, to 6 to 25 in. wide, 0.1196 to 0.25 in. thick.

Slabs, ranging 6 to 26 in. in width, 66 to 180 in. in length, 2½ to 4⅜ in. in thickness, and 800 to 5500 lb in weight, are rolled on the company's blooming mill and pass over a turntable and a run-in table directly into the slab and billet preparation building, which also serves as a slab yard for the new strip mill. At present, all slabs are cooled and conditioned before going to the strip mill furnace, but space is available for the future installation of a transfer between the slab run-in table and the furnace charging table should it become desirable.

From stock, cold slabs are brought by overhead crane to a magazine depiler which feeds them on to the furnace charging table. A double ram type pusher, permitting the charging of either one or two rows of slabs, moves them off the charging table and through the heating furnace.

HEATING FURNACE

At present, one heating furnace is installed, with provisions for the addition of a second unit when desired. The furnace is of the conventional three-zone continuous type, with a capacity of about 60 tons of slabs per hr. Its hearth is 18 ft wide, with lengths of 46 ft in the main heating zone and 14 ft in the soaking zone. The heating zone is supplied with six combination burners on top and six more on the bottom, while six burners overfire the soaking zone. Burners are designed to handle steam-atomized fuel oil or coke oven gas.

The furnace is steel encased, has a suspended roof, and is thoroughly insulated. Automatic control of temperature and fuel-air ratio is applied to each zone, and furnace pressure is also automatically controlled. All controls and instruments are installed in a control house located on the mill

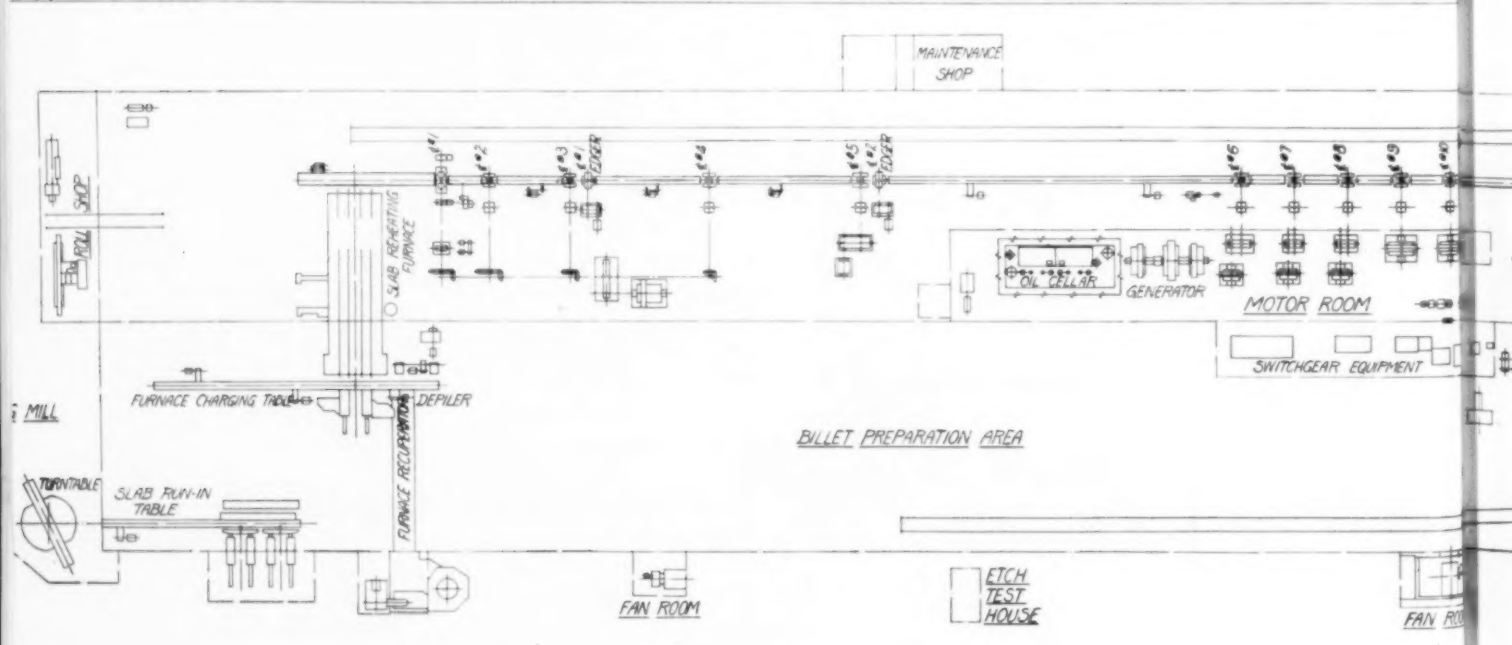


Figure 1 — General mechanical layout of 30-in. hot strip mill, Alan Wood Steel Co., Conshohocken, Pa.

floor near the discharge end of the furnace.

An unusual feature of this furnace is the recuperator which consists of several long alloy steel tubes of large diameter placed in the flue between the furnace and its stack. Air for combustion is pushed through the tubes by a fan rated at 18,480 cfm, 20 oz, and attains a temperature averaging about 700 F.

Heated slabs are discharged from the furnace on to a mill approach table 39 ft long.

TABLE I

	Motor hp	Motor rpm	Gear ratio	Roll rpm	Strip speed fpm
No. 1 scalebreaker	1800	505	Various	12.4	104
No. 2 rougher				21.6	119
No. 3 rougher				35.1	193
No. 4 rougher				45.2	248
No. 1 edger (after No. 3 rougher)	100	600–900	13.78	43.6– 65.4	154–230
No. 5 rougher	1500	662–772	10.72	61.6–71.8	339–396
No. 2 edger	100	600–900	7.44	80.5–121	284–427
No. 1 finisher	1500	280–420	6.53	42.8– 64.2	235–353
No. 2 finisher	1500	280–420	4.22	66.4– 99.7	365–548
No. 3 finisher	1500	280–420	3.4	87.4–123.4	453–679
No. 4 finisher	1800	110–230	Direct	100 –230	550–1264
No. 5 finisher	1800	115–230	Direct	115 –230	632–1264
No. 6 finisher	1800	115–230	Direct	115 –230	632–1264

HOT MILL

The first roughing stand is a vertical scale breaker with cast iron rolls 32 in. in diameter and 8½ in. long, running in roller bearings. No. 2, 3, 4 and 5 roughers are two-high, 30-in. x 21½-in. stands spaced, respectively, 18 ft, 3 ft 6 in., 52 ft 6 in., and 57 ft from the preceding stand. Two vertical edgers, with rolls 19 in. in diameter and 10½ in. long, are installed, one, 7 ft behind No. 3 rougher and the second, 7 ft behind No. 5 rougher.

A delay table approximately 136 ft long separates the roughing train from the finishing train, which consists of six, two-high, 30-in. x 21 1/16 in. stands, spaced on 20-ft centers.

Mill rolls are of steel in No. 2 and 3 roughers and in the two vertical edgers, and these stands are equipped with brass roll-neck bearings. Chilled iron rolls are used in No. 4 and 5 roughers and in the six finishing stands, with composition roll-neck bearings. Roll settings are adjusted through manually operated screws.

A roll shop located at the end of the hot mill building contains a roll lathe and a roll grinder.

The first four units of the roughing train are driven through gearing by a single 1800-hp, 505-rpm, 6900-volt wound rotor motor. Each of the small edging units is driven by a 100-hp, 600 to 900-rpm 250-volt shunt motor. No. 5 rougher is driven by a 1500-hp, 662 to 772-rpm, 600-volt d-c shunt motor.

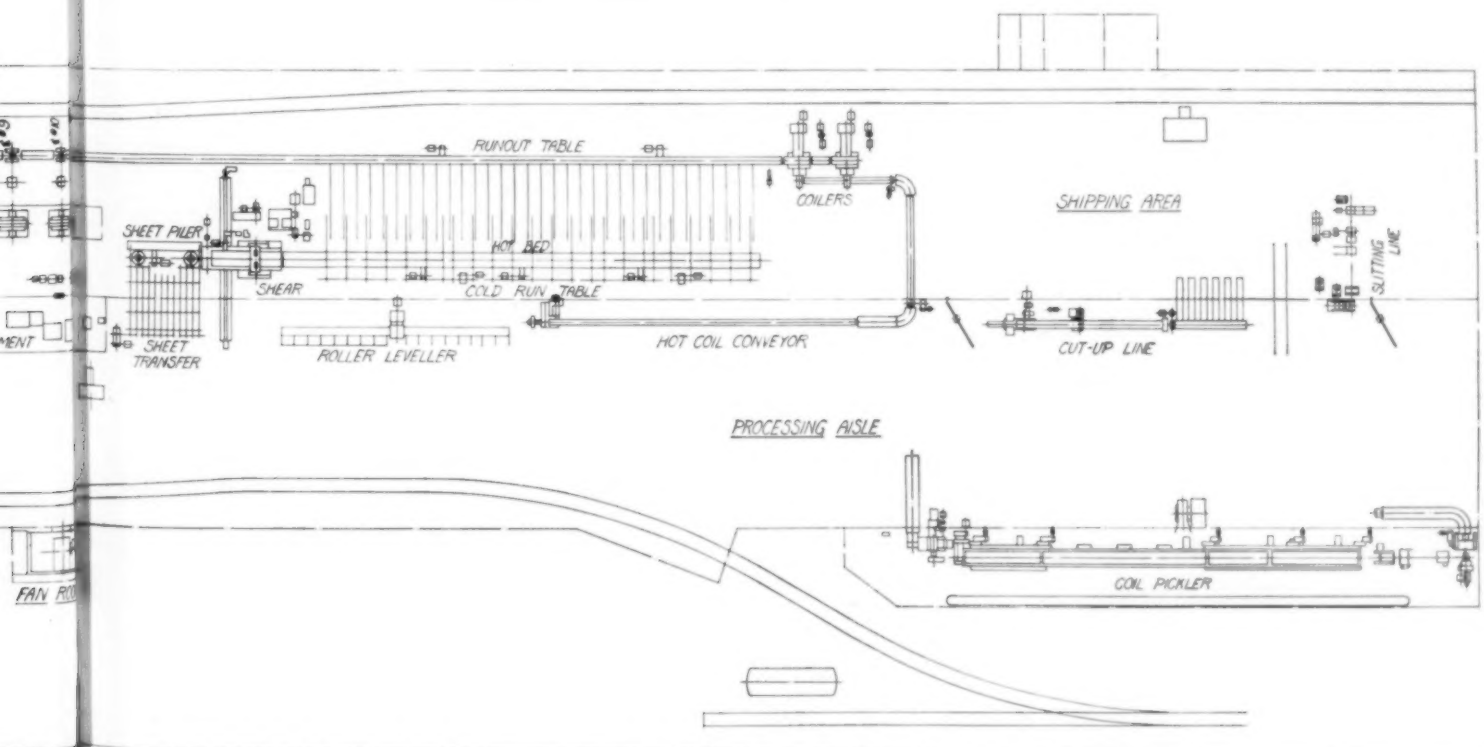
The six finishing stands are individually driven by three 1500-hp, 280 to 420-rpm motors and three 1800-hp, 115 to 230-rpm motors, all of 600-volt, shunt type.

Gear ratios and mill speeds are given in Table I.

Seven solenoid operated loopers are installed along the mill, two located on the delay table between the roughing and finishing trains, and five between successive stands of the finishing train.

As the steel passes through the hot mill, it is subjected at various points to steam jets and water sprays to insure a clean, smooth surface. These jets and sprays are controlled by solenoid operated valves. Water is supplied by a 1000-gpm, 1200-psi centrifugal pump.

(Please turn to Page 126)



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(Continued from Page 123)

Table rollers are of cast type, and in the tables between the mill stands are driven through line shaft and gears by d-c motors. The hot runout table, which extends approximately 290 ft beyond the end of the finishing train, is composed of 128 rollers, individually driven by fifty-three 0.2 to 0.4-hp motors and seventy-five 0.75 to 1.50-hp motors operating under variable frequency of 16.7 to 36.7 cycles.

At the end of the runout table are two down-coilers, each driven by a 50-hp shunt motor. From the coilers a hot coil conveyor extends into the adjacent processing building, making two 90 degree bends to double back in opposite direction to the mill flow.

Rolled product, not intended for coiling, is pushed off the runout table on to a cooling bed transfer approximately 162 ft wide x 32 ft long which leads to a cold run table. This table feeds a flying shear, designed to cut lengths of 5 to 40 ft. The shear is followed by a sheet piler and a sheet transfer over which product may be moved into the adjacent processing bay.

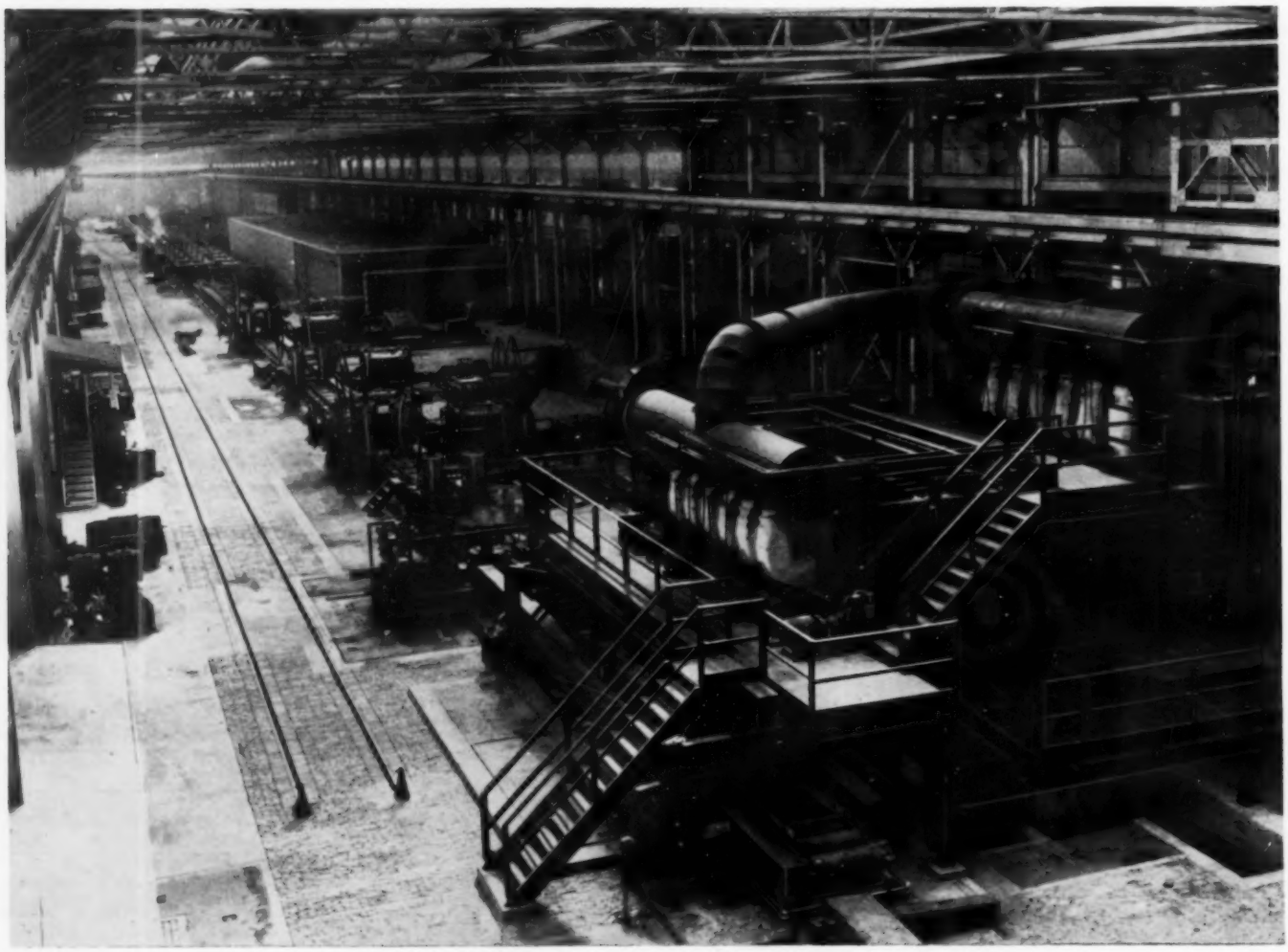
At present, equipment is provided only for hot finishing, and includes a roller leveling line for cut lengths, a combination leveling and cut-up line, a coil slitting line, and a coil pickler. Cold finishing equipment may be another construction project for the future.

MOTOR ROOM

The motor room houses the six drive motors of the finishing train, together with their gear sets, motor-generator sets and all controls and switchgear. Power for the d-c drives which operate under adjustable voltage control is supplied by a motor-generator set composed of two 3000-kw, 600-volt d-c generators driven at 360-rpm by a 8400-hp, 6900-volt synchronous motor. Excitation for these units and for the d-c mill drive motors comes from a set driven by a 300-hp, 440-volt, 1800-rpm synchronous motor and containing a 100-kw generator for excitation of finishing stand drives, a 60-kw generator serving the 8400-hp synchronous motor fields, a 30-kw generator serving the 3000-kw generator fields, a 5-kw generator for the motor on No. 5 roughing stand, and another 5-kw generator serving control units. Two rotating regulator sets are provided for control of bus voltage and power factor. Variable frequency power for runout table motors comes from a set consisting of a 150-hp, 250-volt d-c shunt motor driving a 32-kva, 120 to 220-volt, 16.7 to 36.7-cycle a-c generator and a 100-kw, 56 to 120-volt d-c dynamic braking generator.

The large rotating equipment in the motor room is cooled by filtered forced air from a 130,000 cfm fan, keeping the motor room under pressure. The motors driving the roughing train are not located in the motor room, but are cooled by air from an 18,000 cfm fan.

Figure 2 — Alan Wood's new 30-in. hot strip mill is the first in eastern Pennsylvania. Mill took a little over a year to construct and cost $9,000,000. It is the largest plant addition in the company's 123-year old history. Finishing capacity is estimated at 218,000 tons annually.



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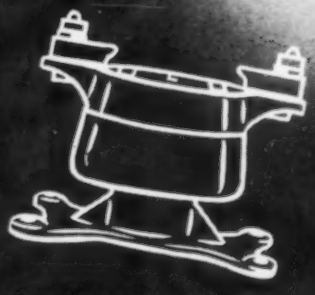

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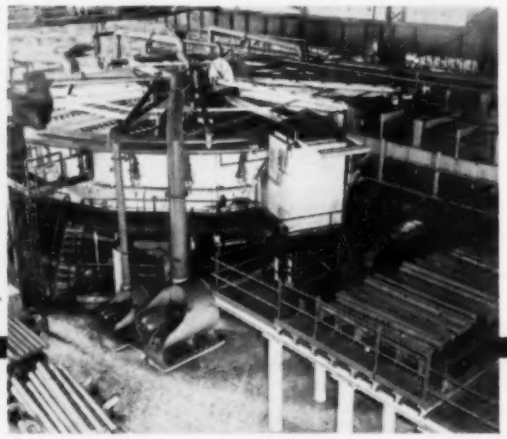

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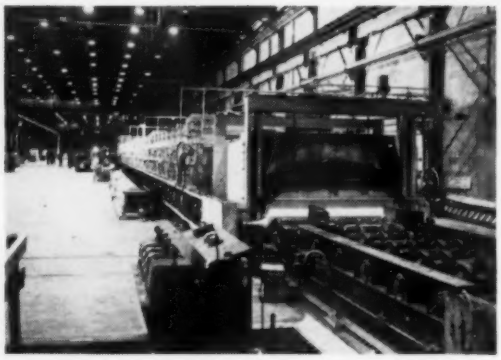

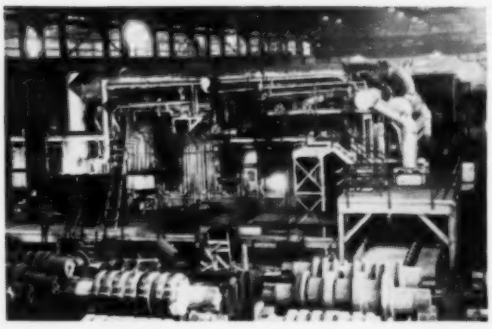

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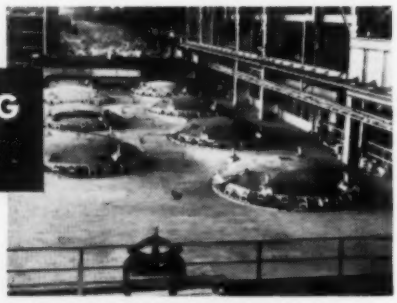

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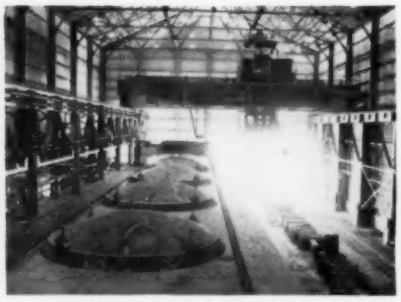

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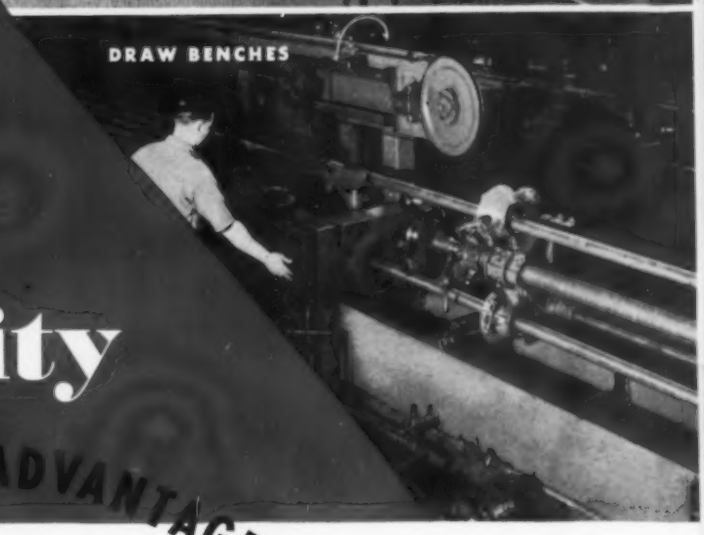

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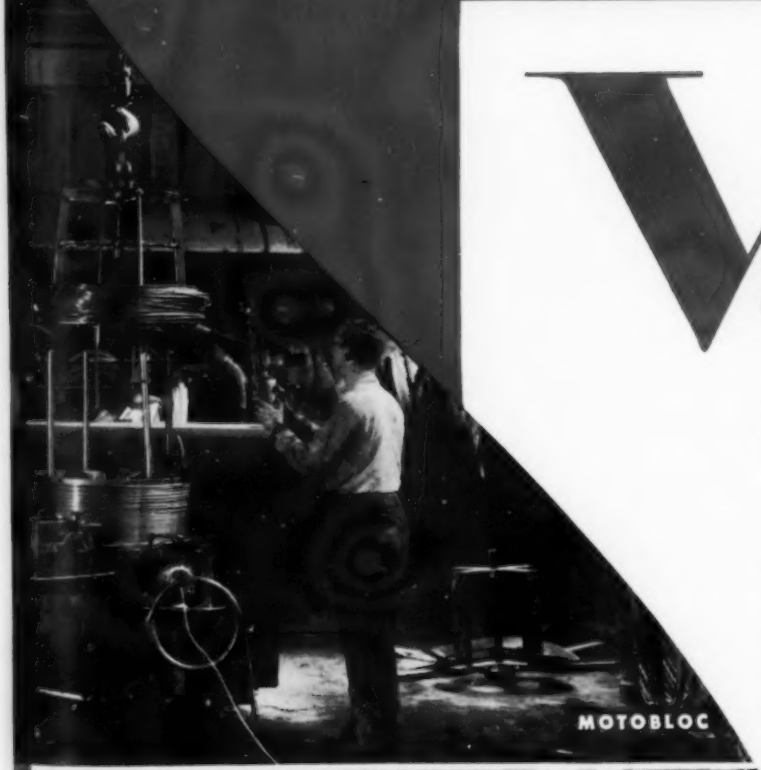

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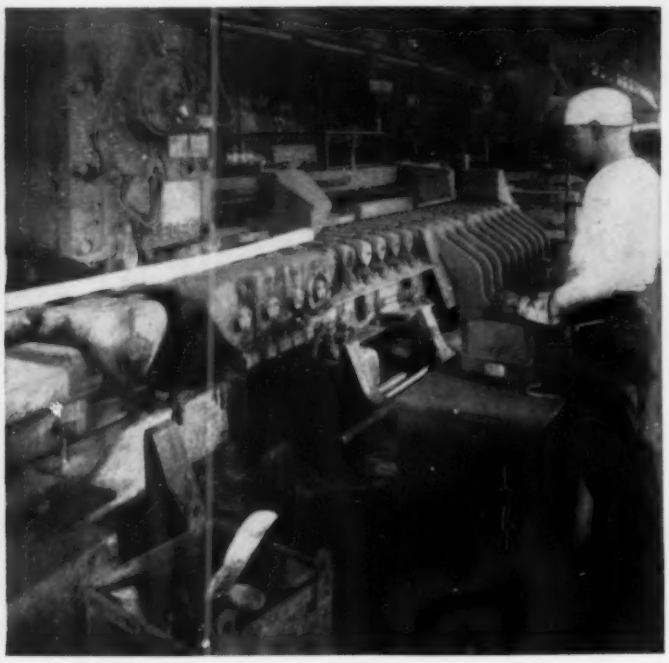
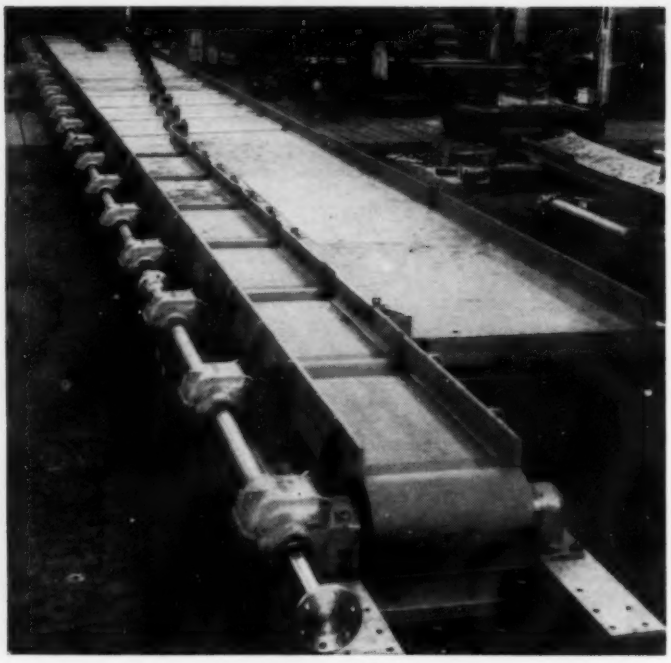


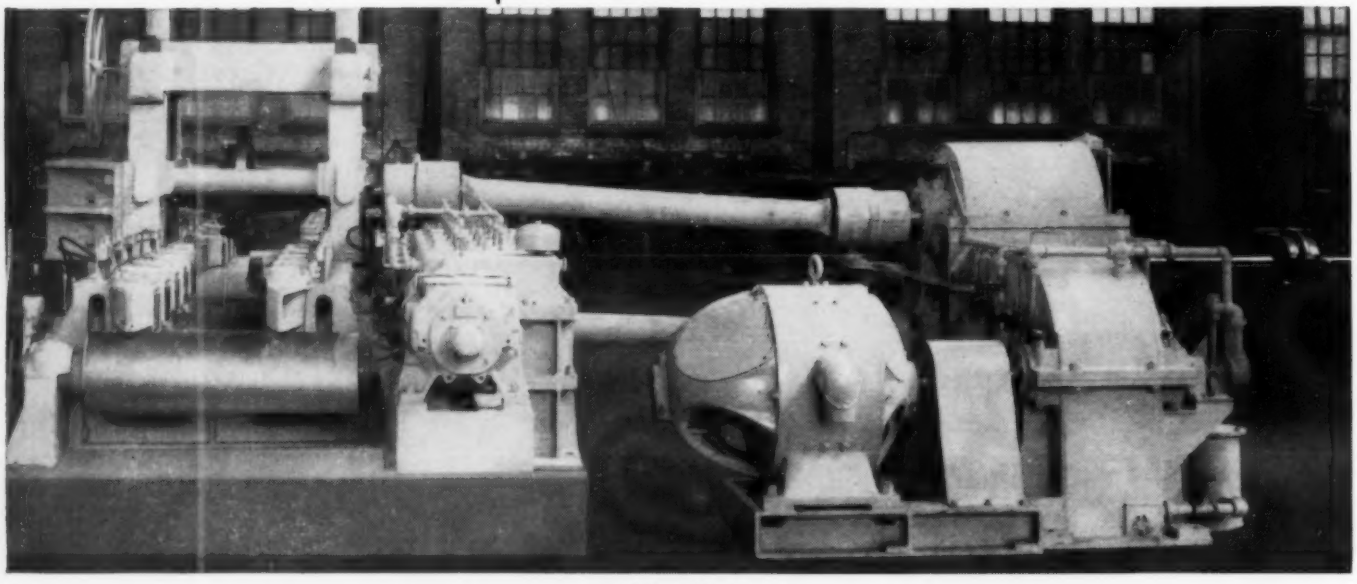
50-ton Hot Billet Shear, Gauge Table & Cradles



Skew Table

Birdsboro...

A name that has meant advanced engineering • and painstaking workmanship in the building of rugged, enduring steel mill equipment for nearly fifty years.



Slitting Shear

BIRDSBORO STEEL FOUNDRY & MACHINE CO. • BIRDSBORO, PA.

OFFICES IN:
Birdsboro, Pa. and Pittsburgh, Pa.

MM-5-50

BIRDSBORO
STEEL MILL MACHINERY

DESIGNERS and BUILDERS of: Steel Mill Machinery • Hydraulic Presses • Rolls • Special Machinery • Steel Castings • Crushing Machinery

"We want THIS BAKER TRUCK!" said Taylor & Boggis Foundry Co.

So—We Sold Them the Pilot Model of Our New FT (100% Functional) Fork Truck which Had Been in Their Plant on Test

Put yourself in our place. Our engineers had been instructed to design a new 3000 to 4000 lb. capacity electric fork truck—a completely functional *"work horse"*—retaining traditional Baker quality and ruggedness and adding features that contribute to greater utility, safety and convenience.

For months they worked like demons—analyzing basic materials, testing controls, motor characteristics, hydraulic equipment, studying every essential truck function, designing, re-designing, assembling, re-assembling.

Finally they said—"HERE IT IS!"

"Looks like a lot of truck," said our management, "but how much will it cost?"

"LESS THAN ANY TRUCK IN ITS CLASS!" was the answer.

"Will it do the job?"

"LOOK AT THESE TEST RECORDS!"

Our engineers had subjected this truck to exhaustive tests covering every conceivable truck function. It had come through with flying colors.

BUT WE WANTED TO BE SURE!

So we selected a plant which had just about the toughest operating conditions you'll find anywhere, and put one of the pilot models on test there.

This plant is a high-production foundry. Abrasive dust, heavy, punishing loads, typical foundry floor conditions, continuous, round-the-clock, three-shift operation—the most strenuous service you'll ever ask of a truck.

Frankly, no industrial truck had ever been able to "stand the gaff" in this foundry.

BUT THE BAKER FT DID!

From the day it was installed, there was NOT ONE MINUTE OF DOWN TIME!

As a result, the company insisted on keeping *this truck:* the pilot model which was in their plant on test!

●

That's the story of the development of the new Baker FT 3000 to 4000 lb. capacity Electric Fork Truck. Production models are now rolling off the assembly line in our new modern plant. Write us, or ask your nearest Baker representative to give you details on the toughest, lowest-priced, fork truck in its class.

Baker FT Fork Truck delivering rough castings to tumbling machine at the Taylor & Boggis Foundry.

THE BAKER INDUSTRIAL TRUCK DIVISION *of The Baker-Raulang Co.*
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In Canada: Railway and Power Engineering Corporation, Ltd.

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PROOF!!!

12 years of continuous service on this four stand tandem cold mill

● This long period of continuous service is one reason why there are more Trabon Automatic Systems in operation than all other makes . . . time tells.

Trabon systems deliver the exact measured amount of lubricant to each bearing —no excess to damage the product being manufactured.

Trabon oil and grease systems are SAFE . . . POSITIVE . . . AUTOMATIC . . SEALED . . . result in lower operating costs, increased production and protection to men and machinery.

Backed by 20 years of experience in engineering and installing lubrication equipment, Trabon can save thousands of dollars for you.

Regardless of the size or type of your machine — whether single or tandem mills for stainless, alloys, aluminum or brass — there is a Trabon system to fill your need. Call or write today.

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TRABON ENGINEERING CORPORATION

1814 EAST 40th STREET • CLEVELAND 3, OHIO

Trabon

OIL AND GREASE SYSTEMS

Date-line Diary...

February 1

▲ The Koppers Co. has been awarded a contract to supervise a $50,000,000 engineering and construction program in Turkey under the ECA. Work consists of terminal facilities and coal preparation plants.

February 2

▲ Atlas Steels Ltd., Welland, Canada is installing the first mills in Canada for the production of stainless sheet.

▲ The Munitions Board reported to Congress that outlays under the national defense stockpiling program have been increased by $556,000,000 raising cost of the entire program to $3,773,000,000.

▲ The mine operators accepted President Truman's proposal for a 70-day truce in the industry. No decision was reached on this by the United Mine Workers.

February 3

▲ No. 1 heavy melting scrap advanced to $31.00 a ton in Pittsburgh, up $1.00.

▲ The National Steel Corp. reported 1949 earnings of $39,311,269 or $16.02 a share compared with $16.35 a share in 1938.

▲ The Armco Steel Corp. announced a new stainless steel alloy possessing high strength and hardness, good corrosion resistance and good fabricating properties.

February 4

▲ F. W. Dodge Corp. reports that contracts awarded for building and heavy construction in the thirty-seven states east of the Rockies in January were $730,855,000, an increase of 51 per cent over January one year ago and a drop of 21 per cent from the preceding month.

▲ Carnegie-Illinois Steel Corp. announced a new construction program which will increase production of cold reduced sheets by 200,000 tons a year in the Chicago district. The program requires no major additions and will be completed in about fifteen months.

▲ Total payroll for the iron and steel industry in 1949 was $2,061,770,000, the second highest in history. Average hourly wage rates were the highest ever at $1.703, and workers averaged 34.5 hours per week. Estimated total employment was 620,500.

▲ Secretary of Treasury Snyder asked Congress to increase revenues $1,000,000,000 through additional taxes on corporation, estates and gifts. Some excise taxes would be reduced for a total of $695,000,000.

▲ U. S. Steel Corp. accepted President Truman's proposal for a 70-day truce in the coal industry.

▲ A number of steel producers in the Pittsburgh district were requested to shut down electric furnaces during the daytime to save coal.

▲ General Refractories Co. has decided to purchase the stock of the Americana-Austrian Magnesite Corp. of Pittsburgh.

February 6

▲ Based on reports from companies having 93 per cent of the steel capacity of the industry, the operating rate of the steel industry is scheduled at 91.5 per cent of capacity for the week beginning February 6, 1950. This is equivalent to 1,744,200 tons compared with 1,774,700 tons one week ago.

February 7

▲ The six blast furnaces at Carnegie-Illinois Steel Corp. Rankin Works set a new production record in January of 192,521 net tons, and the five furnaces at the Ohio Works set a new record of 148,217 tons.

▲ Department of Commerce estimated 1949 U. S. exports of $12,000,200,000 and imports at $6,626,000,000.

▲ American Railway Car Institute reported freight car deliveries in January at 2,395 compared with 8,913 in January 1949. Total backlog on February 1 was 19,026 compared with 12,036 thirty days previously.

February 8

▲ The Inland Steel Co. shut down a second blast furnace because of the coal strike.

▲ John L. Lewis and the soft coal operators resumed negotiations for a new contract.

▲ The E. W. Bliss Co. awarded Westinghouse a $400,000 contract for motors and auxiliary equipment for the single-stand strip mill being constructed for Cantieri Metallurgici Italiani of Italy.

▲ General Electric Co. was awarded a $2,000,000 contract by the Detroit Steel Corp. for the electrical equipment on the new hot strip mill at Portsmouth, Ohio.

February 9

▲ The House Judiciary sub-committee postponed its investigation of the steel price rise to March 15, 16, 17.

▲ Texas Eastern Transmission Corp. started flow of gas through a new 800-mile pipe line from Texas which will supply industry in Ohio, Pennsylvania and New York. The 800-mile Texas-Ohio pipe line cost $73,500,000, and will eventually deliver 235,000,000 cu ft of gas a day.

▲ President Truman's Fact Finding Board ended its hearings today on the coal dispute and started writing its report for the president.

February 10

▲ Production of primary aluminum in 1949 was 1,206,947,014 lb compared with 1,244,358,193 lb in 1948. Shipment of sheet, plate and strip totaled 777,910,955 lb.

February 11

▲ According to the Economic Council, income payments to individuals in 1949 totaled $209,800,000,000, down from $211,900,000,000 in 1948.

▲ The Association of American Railroads reported net income of Class 1 railroads at $436,000,000 in 1949 compared with $698,000,000 in 1948.

February 12

▲ The Census Bureau stated that unemployment rose to a postwar high in the middle of January of 4,480,000, with 56,947,000 persons employed.

▲ The striking soft coal workers refused to return to work in spite of a Federal Court order barring a strike for ten days.

February 13

▲ The Treasury Department estimated that Federal tax collections during the calendar year in 1949 were $40,501,000,000 compared with $42,302,000,000 in 1948.

▲ Based on reports of companies having 93 per cent

of the steel capacity of the industry, the operating rate of the steel industry is scheduled at 90.7 per cent of capacity for the week beginning February 13, 1950. This is equivalent to 1,729,000 tons of steel compared with 1,744,200 tons one week ago.

February 15

▲ Coke plant and blast furnaces of the Kaiser Steel Corp. went on a reduced schedule because of the coal strike.

▲ United Engineering and Foundry Co. will expand its Canton plant at an estimated cost of $600,000 to $700,000.

▲ No. 1 heavy melting scrap rose to $32.00 a ton in the Pittsburgh district.

February 16

▲ NLRB General Counsel Denham revealed that the CIO Steel Workers will ask the NLRB for union shop elections in all basic steel companies.

▲ J. L. Lewis asked a guarantee of 200 days a year, a 7½ hr day, and an increase of 15¢ in the royalty for the welfare fund.

February 17

▲ R. L. Polk & Co. announced that registration of passenger automobiles in the United States in 1949 reached a record total of 4,838,342 units, compared with the previous record of 3,880,206 in 1929.

▲ John L. Lewis renewed his instructions to the striking coal miners to obey the Federal Court order and to go back to work. This message was stronger than the one which was previously sent out.

February 18

▲ Philip D. Reed, chairman General Electric Co., expects sales for the first quarter of 1950 to be about the same as the first quarter of 1949.

February 19

▲ Soft coal miners remained on strike in spite of John L. Lewis' second back to work order.

February 20

▲ Net earnings of the Allegheny-Ludlum Steel Corp. for 1949 totaled $1,976,323 or $1.15 per share of stock after preferred dividends. This compares with $5.05 a share in 1948. Total sales in 1949 were $105,734,721.

▲ Based on reports from companies having 93 per cent of capacity of the industry, the operating rate of the steel industry is 88.8 per cent of capacity for the week beginning February 20, 1950. This is equivalent to 1,692,800 tons of steel ingots and castings compared with 1,729,000 tons one week ago.

▲ Federal Judge Keech signed an order directing the striking coal miners to show cause why they should not be found in contempt for failing to obey a back-to-work order which he issued on February 18.

February 21

▲ The National Steel Corp. declared a dividend of $1.50 per share for the first quarter of 1950, an increase of 25¢ over the previous regular rate.

▲ Department of Commerce reported the country's gross national product for 1949 at $257,000,000,000, or $5,000,000,000 less than 1948. Change in actual volume of goods was probably less when the lower prices are taken into account.

February 22

▲ The United States Steel Corp. reported that shipments of finished and semi-finished steel products on the Monongahela River in 1949 were 96.8 per cent higher than in 1948.

February 23

▲ The Detroit Steel Corp. let a contract to Rust Engineering Corp. to construct a $300,000 slab furnace.

February 24

▲ The Lake Superior Iron Ore Association reported that iron ore consumption in the United States and Canada in January totaled 6,740,047 gross tons. Stocks of ore on hand at the end of January totaled 32,003,928 tons compared with 31,904,181 tons one year ago, 193 furnaces were in operation on February 1 compared with 195 one year ago.

▲ General Motors cut prices from $10 to $40 on its cars and trucks, and according to its cost of living formula will cut wages 2¢ an hour.

▲ Federal Judge Keech directed United Mine Workers to face contempt charges Monday, February 27th.

February 25

▲ Eastern Railroads are planning substantial reductions in freight rates on iron and steel products to meet truck competition.

February 26

▲ The AISC reports that the estimated total bookings of fabricated structural steel products dropped slightly in January to 116,987 tons, compared with 124,251 tons the month before and 130,418 tons the previous year.

February 27

▲ The Pennsylvania Railroad reported net income for 1949 of 95¢ a share compared with $2.61 a share in 1948.

▲ The United Mine Workers pleaded not guilty to government charges that the union is defying a court injunction against a strike in the soft coal fields.

▲ Based on reports from companies having 93 per cent of the steel capacity of the industry, the operating rate of the steel industry is scheduled at 73.7 per cent of capacity for the week beginning February 27, 1950. This is equivalent to 1,404,900 tons of steel ingots and castings compared with 1,692,800 tons one week ago.

▲ Gwilym A. Price announced that the Westinghouse Electric Corp. earned more money in 1949 than in any other year. Net income was $67,268,555 or $4.95 a share after preferred dividends. This compares with $4.11 a share in 1948. Net sales in 1949 totaled $945,699,382.

▲ The Bethlehem Steel Corp. announced that it had increased its ingot capacity 800,000 tons to 15,000,000 tons in 1949.

February 28

▲ The House sent back to a House-Senate conference the freight absorption bill which had been up for approval.

▲ Pittsburgh Consolidation Coal Co. cut the quarterly dividend ⅓ and salaries from 5 to 20 per cent.

▲ Lloyd's Register of Shipping reports that merchant vessels launched in 1949 totaled 633,306 tons, a rise of 506,888 tons over 1948.

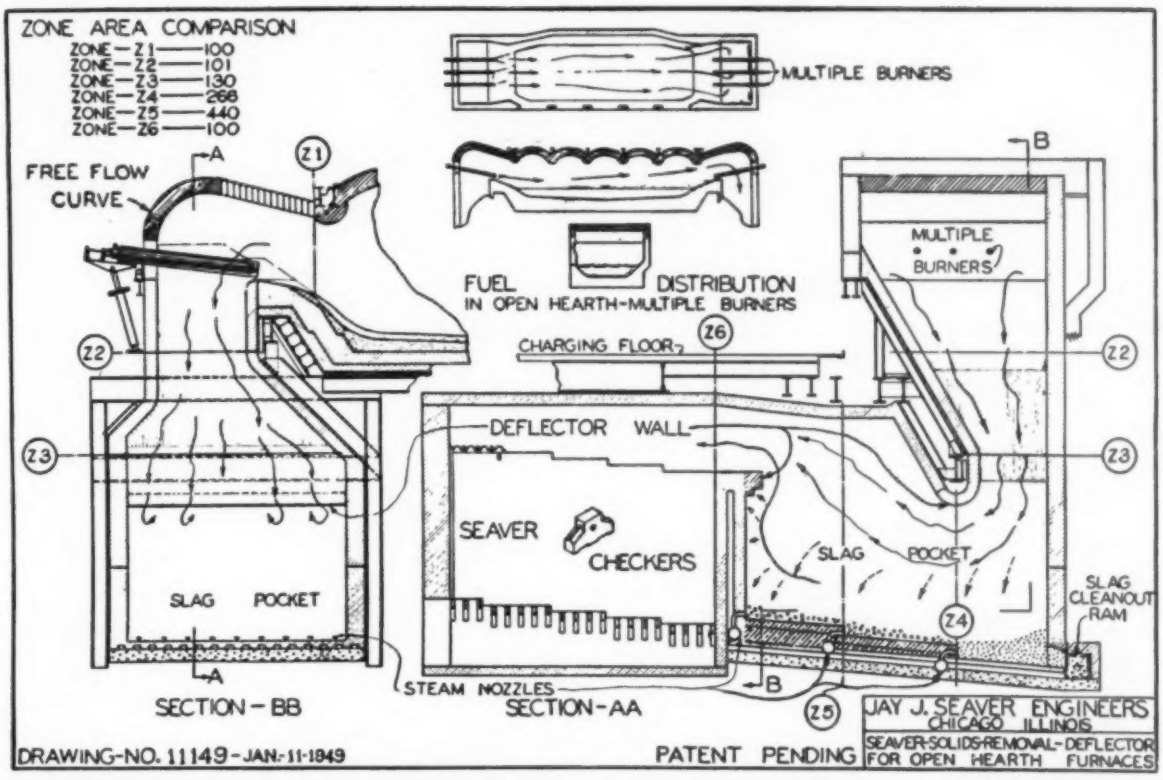
▲ The ECA approved installation of a semi-continuous hot strip mill at Ougree, Belgium for S. A. Ougree-Marihaye. Estimated cost of the whole project is $16,800,000. The 66-in. hot mill will include a 4-high rolling mill as well as 4-stand finishing equipment which will produce about 378,000 metric tons of plates and sheets per year.

▲ The American Swedo Iron Corp. plant at Danville, Pa. is to be shipped to San Juan, Puerto Rico where it will be set up. Plant includes a bar mill and other facilities. Estimated capacity will be 12,000 tons per year.

▲ The Carnegie-Illinois Steel Corp. cut the price of armature and electrical grade sheets $5.00 a ton, transformer grade 90 was reduced $8.00 a ton and transformer grade 80 was reduced $13.00 a ton.

JAY J. SEAVER ENGINEERS

introduce



IMPROVED OPEN HEARTH DESIGNS

for NEW or EXISTING Furnaces

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Save on Tap to Tap Time
with faster charging and faster melt down

Save on Fuel
Increased heat recovery; improved combustion

- Solids Removal Deflector
- Multiple Burners
- Continuous Slag Removal
- Large Self-Sealing Doors
- Improved Reversing and Air Valve Equipment
- Increased Checker Heating with SEAVER Cross-Vent Checkers
- Elimination of Checker Lancing

Write Today for blueprints and further information. We shall be happy to show you how existing open hearth furnaces can be altered or new furnaces built to secure these cost-saving advantages.

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Consulting—Design—Construction—Reports—Appraisals—Investigations—Management and Operation—Thirty-Five Years Experience in the Industry

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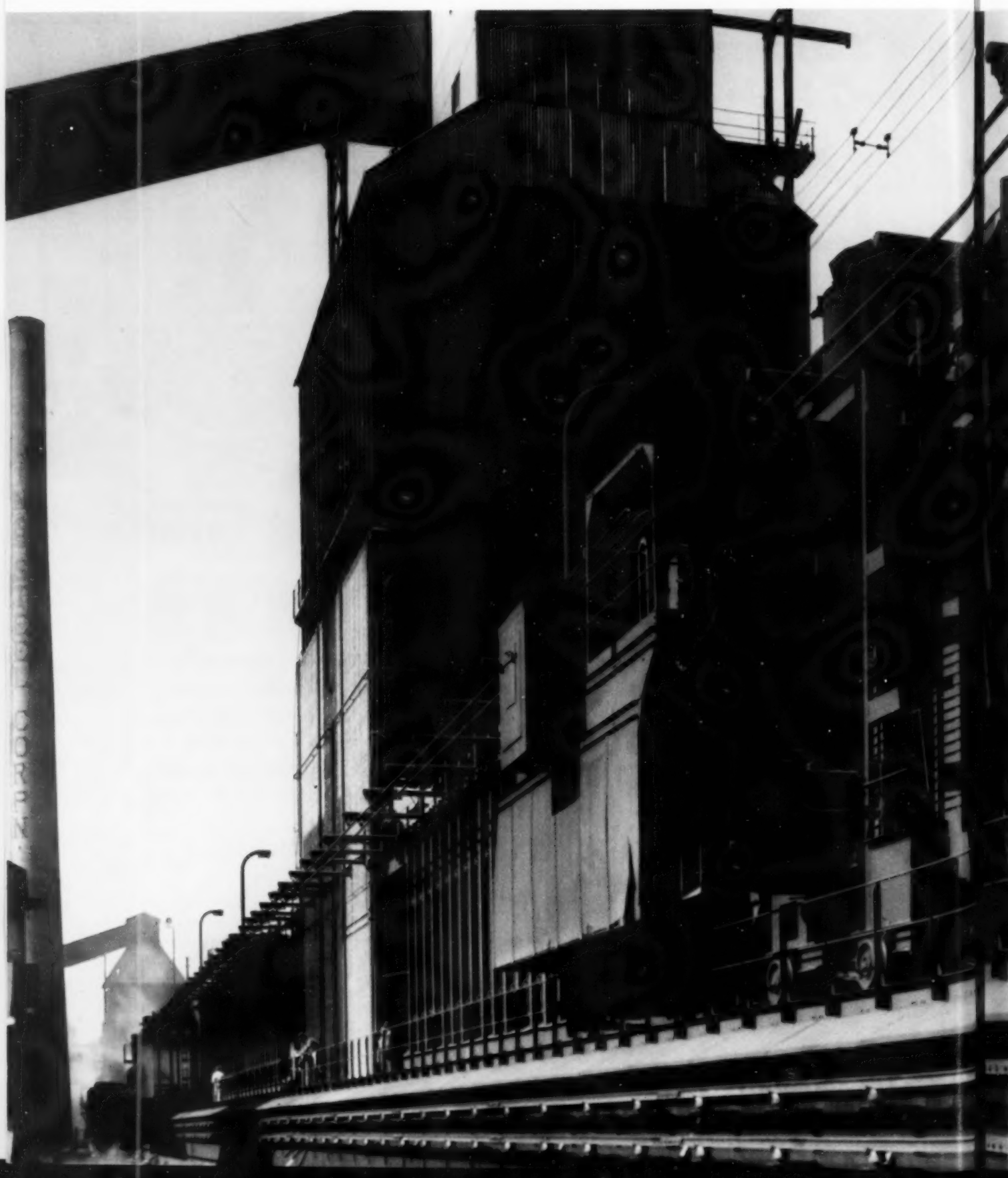
→ To give you greater coke-producing capacity . . .

Koppers constantly improves



its coke-oven installations

Recently, the Engineering and Construction Division of Koppers Company completed 106 new coke ovens for the East Steubenville Plant of the Wheeling Steel Corporation. This installation is a good example of the way Koppers, through the years, has increased the carbonizing capacity of its coke ovens.

Built in two batteries of 53 ovens each, these 106 new ovens carbonize 2594 net tons of coal per day. This compares with a carbonizing capacity of 2500 net tons of coal per day from Wheeling's 145 old Koppers-type ovens. In other words, the *106 new ovens* produce more coke than the *145 old ovens* . . . real production progress, indeed.

These new Koppers-Becker Underjet Coke Ovens are underfired with coke-oven gas, and are equipped with waste-gas recirculation; also, there is provision for future blast-furnace gas underfiring. Each individual oven is 40 feet, 6½ inches long, 13 feet high and 18 inches in average width, with a 3-inch taper.

Koppers Company and coke ovens have long been synonymous. But, in *any* problem related to coal carbonization, Koppers engineers are specialists and are always available for consultation and advice.

Koppers Company and its subsidiary, Freyn Engineering Company, also offer comprehensive metallurgical services in the design and construction of blast furnaces, open-hearth furnaces and sintering plants. Also, in the engineering of mills and other steel plant facilities.

KOPPERS

ENGINEERING AND CONSTRUCTION DIVISION

KOPPERS COMPANY, INC.

PITTSBURGH 19, PA.

106 new Koppers-Becker Underjet Coke Ovens designed and constructed by Koppers Company, Inc., for the East Steubenville Plant of the Wheeling Steel Corporation.

Speer carbon brushes provide dependable commutation... the utmost freedom from overheating, sparking, excessive wear and energy losses. Result—*peak motor performance*... a vital factor in the economical operation of electrical lift trucks. And, equally important, no costly material handling delays.

These brushes are only one of the many types that Speer has developed to match mechanical and electric service characteristics. For more than 50 years Speer's experience in meeting brush requirements of machine design or maintenance is at your service.

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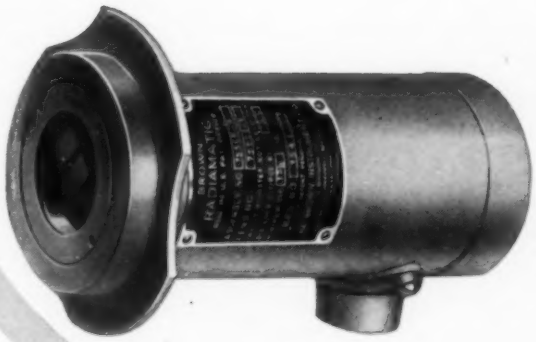

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ADVANCED heating techniques and forming methods are setting the pace for a totally new concept of economical production operations.

And, right in step with such developments is the Brown approach to fast and accurate temperature measurement. The Radiamatic reads temperatures, ranging from 200° to 3200° F., with unprecedented speed and precision . . . on stationary, moving or revolving work. It is unaffected by vibration, mechanical shock, corrosive atmospheres and ambient temperatures. The *ElectroniK* Strip-Chart Recorder is a perfect partner for the Radiamatic . . . accurately records the slightest temperature change in less than two seconds.

Check on these "perfect partners" for greater efficiency in all of your heating and forming operations. Call in your local Honeywell engineer for complete information . . . he is as near as your phone!

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Johnston Corrugated Cinder Pot Performance Key to Slag Handling Economy

View showing Johnston Corrugated Cinder Pots at slag dump, Weirton District

Close-up of Johnston Corrugated Cinder Pot

Continuous Developments Increase Service Life of Johnston Corrugated Cinder Pots

Slag Handling is expensive business—part of the cost of every ton of steel. But when you apply Johnston Corrugated Cinder Pots and Slag Handling Equipment you'll find their performance an important factor in keeping slag disposal at the lowest cost-per-ton of steel produced.

Every Johnston Corrugated Cinder Pot is engineered for its specific job. That's why they establish records for heat-hours of service life—why they are so economical for use in blast furnace or open hearth slag disposal operations.

Then, too, you'll find that our engineers are constantly developing and improving methods and equipment for more efficient slag handling. This continuing research is reflected in reduced slag disposal costs when you adopt Johnston Corrugated Cinder Pots and Slag Handling Equipment.

Tapping a 480 ton open hearth heat in two 250 ton ladles, the slag being handled by two 400 cubic foot Johnston Corrugated Cinder Pots

Don't forget that it pays to *keep your eye on what's new at Mack-Hemp.* Just write or phone and we'll show you how we can expedite your slag handling by installing this modern equipment.

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PITTSBURGH AND MIDLAND, PA.

Industry News...

600,000,000 TONS OF SEMI-SMOKELESS COAL FOUND IN GEORGES CREEK LOWER BEDS

▲ Discovery of more than 600,000,000 tons of semi-smokeless coal in the lower beds of the Georges Creek field in Allegany and Garrett Counties, Md., was announced recently by the Department of the Interior.

The new reserves are found in 10 coal beds buried below the two that have provided most of the field's coal production. Those two beds have been mined for many years and are being worked out. As a result, production, which was about 2,250,000 tons a year before 1931, is now approximately 1,800,000 tons.

Little was known about the coals in the lower beds until the Bureau of Mines and the U. S. Geological Survey, with the cooperation of the Maryland Department of Geology, Mines, and Water Resources, explored them between 1944 and 1946. Diamond drilling, examination of operating mines and accessible abandoned ones, and a geologic study of the area yielded the estimate of reserves. Only coal beds 18 in. or more thick were included.

The coals rank as low-volatile bituminous, and carbonization tests showed that they yielded strong coke. It was found that the ash and sulphur contents, although rather high, can be reduced by washing, and that some of the coals may be suitable for use in blends to produce metallurgical coke. Another suggested use is as fuel in nearby metropolitan areas, such as Washington and Baltimore.

A technical paper describing the studies observes that while it may not be economically feasible to mine 18-in. coal in the Georges Creek field at present, the estimate of reserves includes over 150 million tons in beds over 36 in. thick, and more than twice that quantity in beds from 24 to 36 in. thick. It also observes that while recovery of coal from mines now operating in the field averages 50 to 60 per cent, modern mechanized mining methods should increase recovery to 75 or 80 per cent.

INSTALL 36 NEW TYPE NAIL MACHINES

Installing the last three of 36 new type nail-making machines, Joliet works of American Steel and Wire Co. is ready for a spring building boom. Each set of six units is capable of turning out 20 tons of roofing nails each week. Much faster than old type machines, which they replaced, the new ones produce 325 nails a minute, ranging from ¾ in. to 2 in. long. This production line of 24 machines is supplemented by another line of 12 elsewhere in the nail-making department of this U. S. Steel subsidiary.

BIRDSBORO APPOINTS THREE SALES AGENCIES

▲ Birdsboro Steel Foundry and Machine Co. announces the appointment of three manufacturer's agents. Two of the new agents will handle its line of presses and hydraulic equipment. The third will handle steel castings.

Miller-Joyce, located at 122½ S. Vermont Ave., Los Angeles, Calif., has been appointed to handle all types of Birdsboro hydraulic presses and related equipment in the territory of Southern California and Arizona. Whitty Engineering Co., of 10 High St., Boston, Mass., will handle hydraulic presses and related equipment in the New England states. The J. R. Allen Co., with offices at 402 Swetland Building, Cleveland, Ohio, will act as agent for Birdsboro steel castings, both rough and machined, in the state of Ohio, with the exception of counties in eastern Ohio bordering Pennsylvania and West Virginia.

FOLLANSBEE EXPANDS ROCHESTER WAREHOUSE

▲ Follansbee Steel Corp. announced that an expansion program was under way in the Follansbee metal warehouse in Rochester, N. Y., involving a move to larger warehouse quarters.

A steady improvement in industrial outlook for the upper New York state area served by the warehouse was given as a chief factor in initiating expansion plans.

The Rochester warehouse is one of three Follansbee metal warehouses. The two others are in Pittsburgh, Pa., and Fairfield, Conn.

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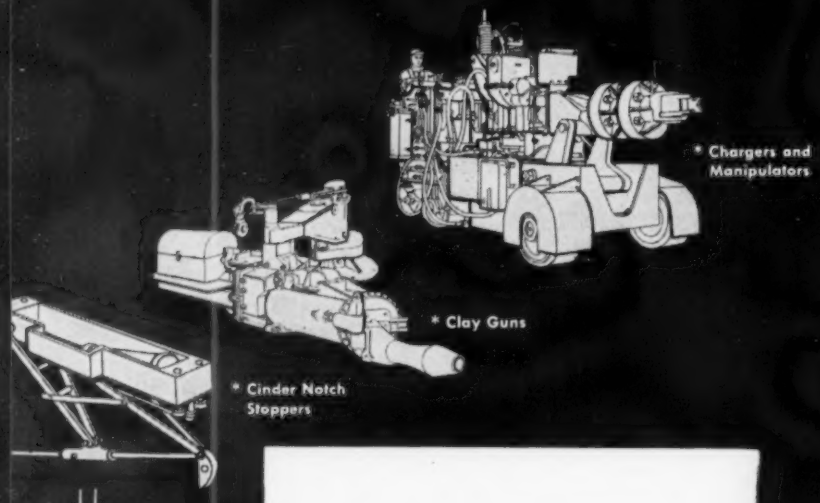

*

When you buy any of the products shown on this page for furnace or mill or forging floor, it will pay you to specify BROSIUS. Wherever you see the well-known mark of BROSIUS, you'll find equipment keenly and specifically designed to do the best job according to the needs of the plant for which it was intended . . . you'll find ruggedly-built and sensibly-engineered machinery easy to operate and maintain. Write without obligation for detailed information on any BROSIUS product. Call on us today.

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ELECTRICAL GROUP TO MEET IN BALTIMORE

▲ Of interest to the electrical men in the steel industry is the meeting of AIEE District No. 2 which will be held in Baltimore, Md., on October 3, 4 and 5, 1950. This district includes the states of Ohio, West Virginia, Pennsylvania, New Jersey, Delaware and Maryland.

BRAKE SHOE FIRM CONSOLIDATES IN CANADA

▲ American Brake Shoe Co. announces the consolidation of all operations of its Canadian subsidiaries into one corporation, the Dominion Brake Shoe Co., Ltd., a wholly owned subsidiary. The operating assets and business of Joliette Steel, Ltd., and Ramapo of Canada, Ltd., were ac-

(*Please turn to page 144*)

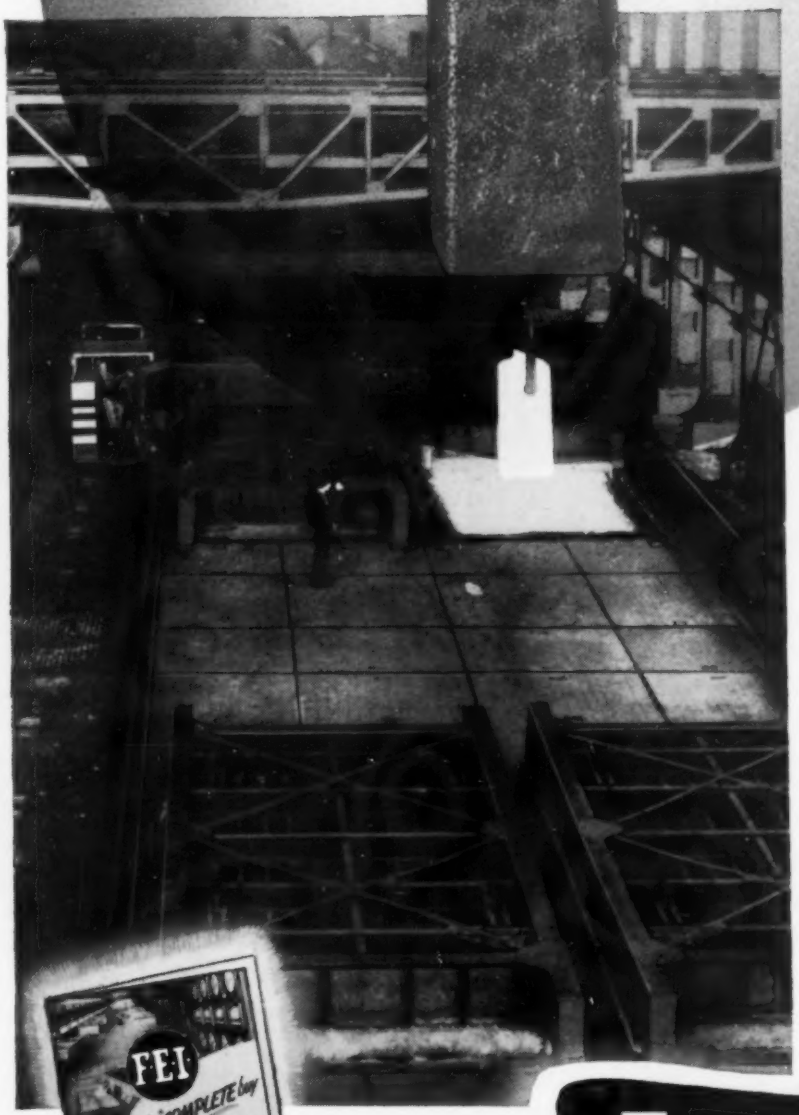
HOLLOW FORGING INGOTS

Industry's demand for larger and larger hollow forgings is making it necessary to cast ingots in sizes beyond anything ever before attempted. Recently Bethlehem Steel Co. has completed an ingot mold believed the largest in existence, capable of producing an ingot of 134-in. diameter, weighing approximately 720,000 lb. Shown here is the stripping of the first ingot cast in this mold, in No. 3 open hearth at the Bethlehem, Pa., plant. Ingots of this size will be used in making the hollow forged vessels of large inside diameter required by the chemical industries.

The Complete Buy F·E·I for Greatly Improved

INGOT HEATING

new regenerative soaking pits



- Completely Automatic
- High Air-Preheat
- Minimum Scaling

MODERN TO THE Nth DEGREE . . . Latest records show greatly increased output of ingots with minimum fuel consumption.

FIRED BY COLD BLAST FURNACE GAS or any other fuel. F.E.I. Soaking Pits provide extremely high preheated air temperatures.

UNIFORM HEATING, controlled automatically. No impingement. No overscaling. No washing. Minimum maintenance... Bottom making practically eliminated. This is due to extremely accurate control of temperature and atmosphere.

Get the facts about F.E.I.—
the complete buy—from original
planning through to actual production.

F-4

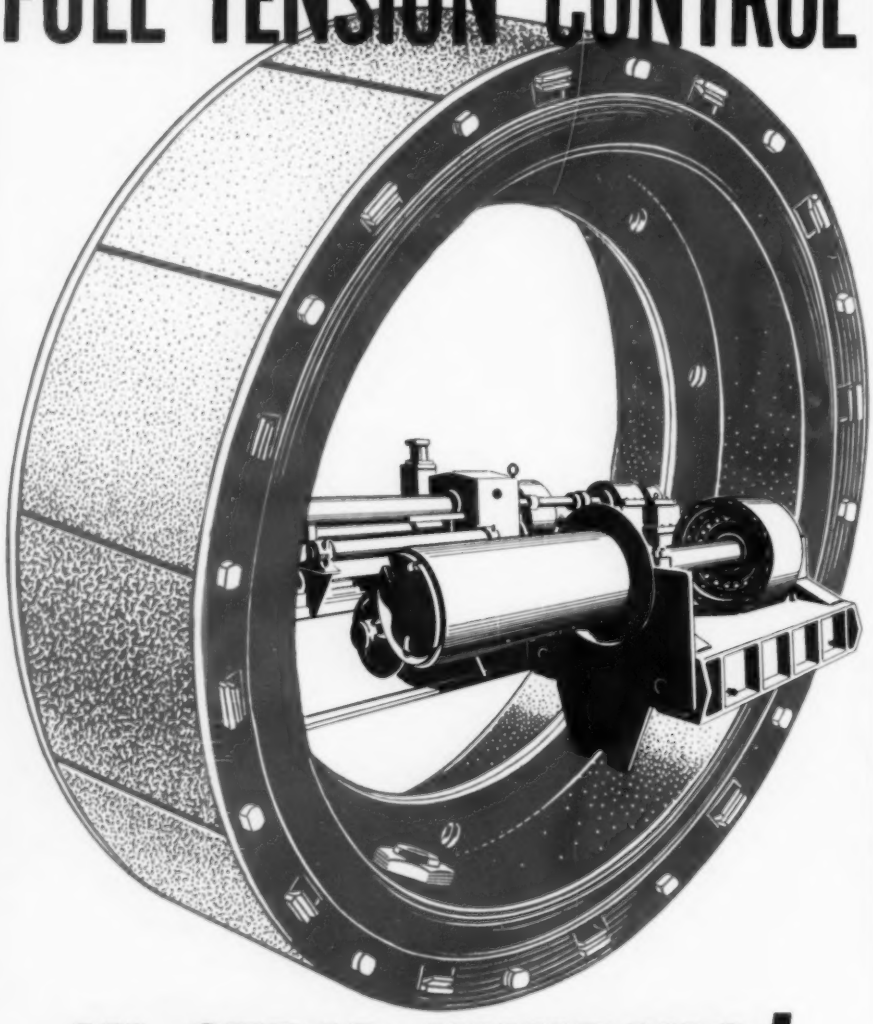
Write for This Bulletin covering all types of F.E.I. Heat Treating Furnaces.

Furnace Engineers Inc.

F.E.I. Building • 1551 West Liberty Avenue • Pittsburgh 16, Pa.

FAWICK CLUTCHES DELIVER

FULL TENSION CONTROL



IN STRIP WINDING!

Now you can have full tension control for improved coil winding operations! The sensitive clutch action of Fawick Type "E" units permits faster, more accurate production of coiled materials.

These long-wearing units operate by remote control without old-style mechanical linkage requiring lubrication and adjustment for wear.

Fawick Clutches on your machines will insure higher production standards through less waste and more efficiency.

For specific information on all advantages of Fawick Industrial Clutch and Brake Units, write to the Main Office, Cleveland, Ohio, for Bulletin 300.

All desirable clutch characteristics are built into Fawick Airflex units

FAWICK Airflex CO., INC.
9919 CLINTON ROAD CLEVELAND 11, OHIO

(*Continued from page 142*)

quired by Dominion Brake Shoe Co., Ltd.

With this consolidation, Dominion Brake Shoe will operate all of the Canadian plants of the parent company through five divisions. These operating divisions will be the Brake Shoe division, Joliette Steel division, Canadian Ramapo division, American Brakeblok division, and Kellogg division.

Dominion Brake Shoe Co., Ltd., will make its principal office at 1405 Peel St., Montreal, Canada. It will continue to operate plants located at Lindsay, Niagara Falls and St. Thomas, in Ontario, and Joliette, Quebec.

POWER CONFERENCE TO BE HELD IN APRIL

▲ The AIEE Power Conference will be held April 19 and 20 in the William Penn Hotel, Pittsburgh, Pa. On April 19 the subject will be power generation and on April 20 the subject will be industrial power systems.

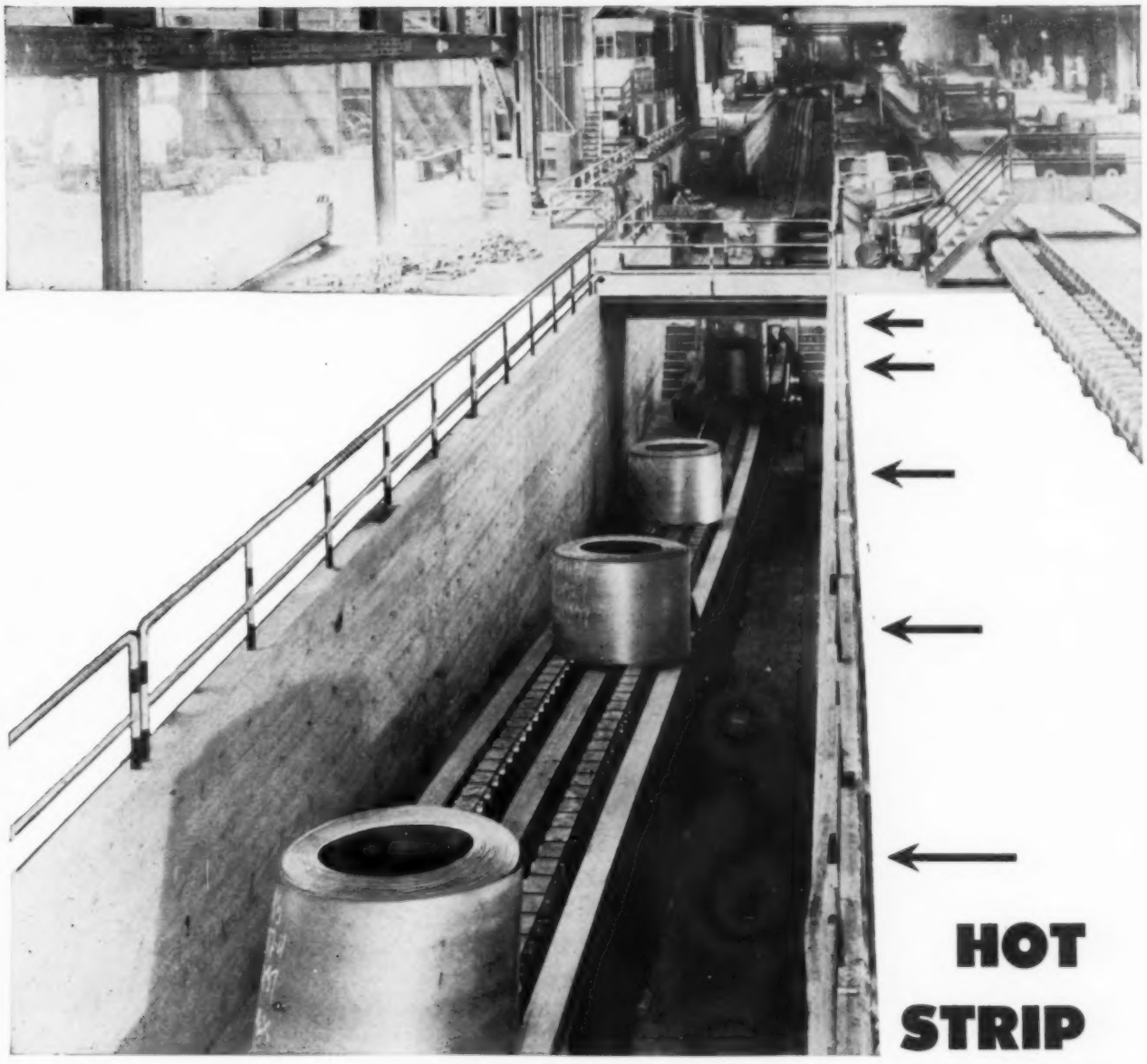
CHEMICAL FIRM ACQUIRES OHIO PLANT

▲ Dacar Chemical Products Co., Pittsburgh, Pa., announced that it has acquired an additional plant at East Liverpool, Ohio, for the manufacture of its chemical products sold to steel plants, foundries and other industries. The plant site consists of buildings on a four-acre plot with railroad siding.

General offices and research laboratory will remain at the Pittsburgh plant. The new plant will provide approximately 50 per cent increased capacity for the company's existing products and facilities for new products recently developed.

GENERAL REFRACTORIES EXPANDS FOREIGN TRADE

▲ General Refractories Co. announces that it has entered into a contract to purchase all of the outstanding capital stock of the American-Austrian Magnesite Corp. of Pittsburgh, Pa. This corporation owns all of the stock of Austro-American Magnesite Co., an Austrian corporation, which owns and operates magnesite deposits and a refractory brick plant near Radenthein, Austria.



HOT STRIP COIL HANDLING SYSTEM

at Gary Sheet and Tin Mill, Carnegie-Illinois Steel Corp.

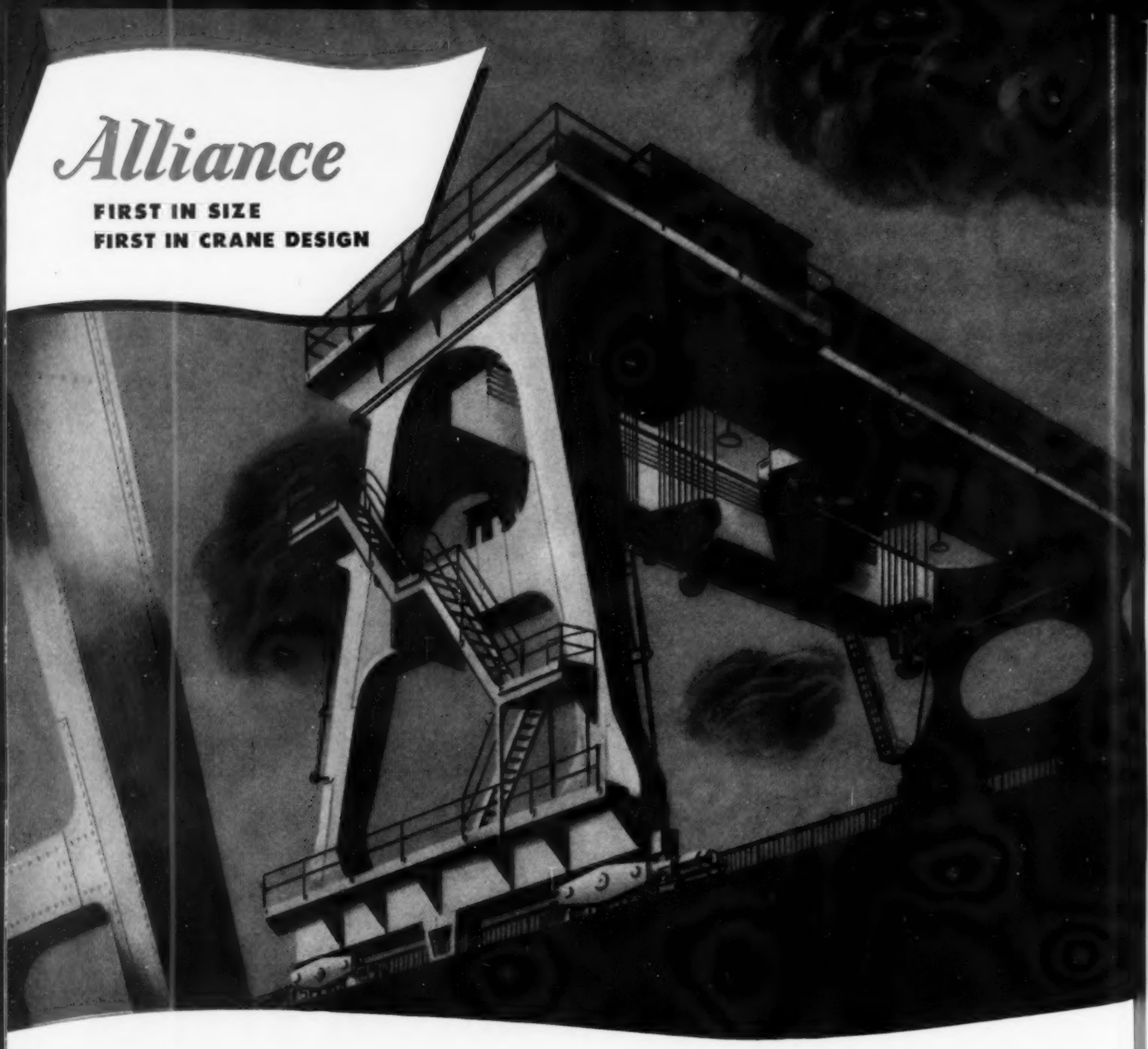
This Link-Belt Double Strand Chain Conveyor serving 3 coilers, provides gentle and controlled transportation of hot coils for maximum mill yield. The platen top of the chain provides adequate bearing surface for the edges of the coiled strip; the space between the chains allows for air passage for cooling on the conveyor. Chain design is rugged, with chain loads transmitted through ample chain joints. The weight of each 10 ton coil is distributed over a number of outboard rollers which provide maximum stability.

The above installation includes three hydraulic conveyor-loaders, two lift and turn units for 90 degree transfer of coils and five side discharge unloading down-tilters.

Link-Belt Engineers are always available to discuss your conveying and power transmission problems.

LINK-BELT COMPANY

Chicago 9, Indianapolis 6, Philadelphia 40, Cleveland 15, Pittsburgh 13, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8. Offices in Principal Cities. 11,828



● We produce big and unusual cranes. We're delighted with unheard of and almost impossible applications for cranes. For example, above is a 270-ton gantry crane installed fifteen years ago on this dam. Successful operation of the dam depends on the crane. Similarly, other huge installations depend on **big Alliance cranes.**

On this crane two 135-ton trolleys can act independently or in combination when lifting loads in excess of 135 tons. One trolley is equipped with a 20-ton auxiliary hoist to handle lighter loads.

For fifty years, Alliance has been designing, engineering and building giant cranes for heavy industry. Where unusual types of cranes are required—for any service—Alliance engineering experience and diversified background of its personnel is generally sought.

Thousands of Alliance cranes are on the job today hoisting and shifting gigantic loads . . . safely, smoothly, quickly, economically. Always rely on Alliance to give your plant dependable extra lifting power.

BIG
CRANES

THE ALLIANCE MACHINE COMPANY

MAIN OFFICE
ALLIANCE, OHIO • PITTSBURGH OFFICE
1622 OLIVER BUILDING, PITTSBURGH, PA.

LADLE CRANES • GANTRY CRANES • FORGING MANIPULATORS • SOAKING PIT CRANES • STRIPPER CRANES • SLAB AND BILLET

Floyd L. Greene, president of General Refractories Co., states that this acquisition is scheduled to be completed by spring. It will enable the company to apply its American patents, processes and "know-how" in the most important field of specialized refractory production outside the United States. Through this purchase the company will acquire additional facilities and sources of raw materials for competing in worldwide refractory markets.

FOSTER-WHEELER CORP. ORGANIZES FRENCH FIRM

▲ Foster-Wheeler Corp., New York, has organized a French subsidiary, Societe Foster-Wheeler Francaise, for handling European construction activities. The French company will maintain offices at 6, Rond Point des Champs Elysees in Paris. R. M. Serre will direct the sales work on the continent of Europe with headquarters at the Paris office.

AMERICAN AIR FILTER ACQUIRES ILLINOIS FIRM

▲ American Air Filter Co., Inc., Louisville, Ky., and Herman Nelson Corp., Moline, Ill., recently merged their interests, with the former company remaining as the surviving corporation.

Each organization will continue to operate from its respective headquarters, with present management and field representation.

UNITED ENGINEERING EXPANDS AT CANTON

▲ United Engineering and Foundry Co. of Pittsburgh, Pa., announces an expansion program which will soon begin at its Canton, Ohio, plant and which will add about 12,500 sq ft to their present machine shop and shipping facilities. The cost of the entire project is estimated between $600,000 and $700,000 and will include the purchase of some new machine tools.

The new building and the new machine tool acquisitions will be devoted mainly to the grinding and other finishing operations on large rolls. A new tool and gage room will also be incorporated into the new area. Designed as a 140 ft extension

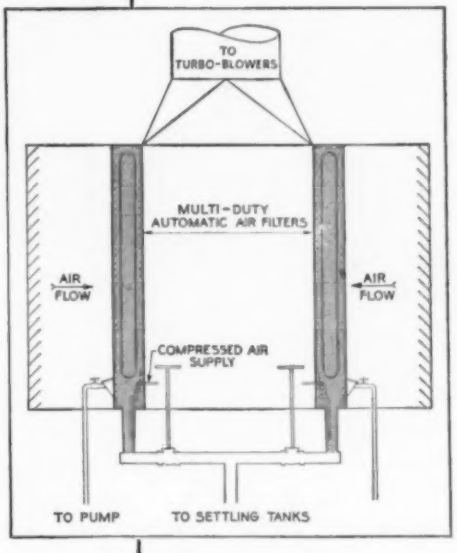
Filter the air

and you can

forget impeller blade erosion

YOU'VE got a maintenance problem in the making when you feed a turbo-blower raw air. The seemingly harmless particles of dust and dirt it contains become killers when they enter a high speed, rotary blower—and rapid wear and erosion of the impeller is the costly end result.

Scores of mills have solved this problem economically with the installation of AAF Multi-Duty Air Filters at the blower intake. Diagram at left shows a typical installation in which provision has also been made for quickly changing and cleaning the filter's oil bath.



The AAF Multi-Duty is an automatic self-cleaning air filter. Overlapping panel construction of the filter curtain combines positive self-cleaning and high efficiency air cleaning as integral functions of the operating cycle. Uniformly constant air supply is assured as operating resistance remains fixed when once established for a given dust concentration.

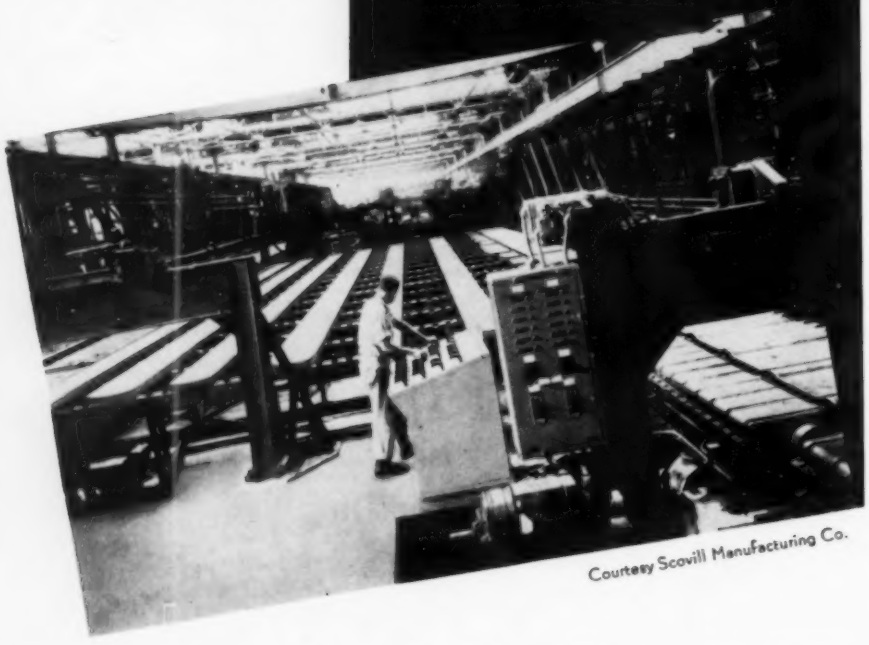
Here's one more opportunity to eliminate a possible source of shutdowns and costly repairs. For complete information on Multi-Duty's record in turbo-blower service, call your local AAF representative or write direct to—

AMERICAN AIR FILTER COMPANY, INC.
302 Central Avenue, Louisville 8, Ky.
In Canada: Darling Bros., Ltd., Montreal, P. Q.

AAF

AIR FILTERS
AND ELECTRONIC PRECIPITATORS

What Builds a Reputation in the CONVEYER BUSINESS?



It's experience that builds a reputation in the conveyer business—and only years of dealing with thousands of conveying problems can provide it. The lessons learned along the way—the good jobs—the difficult ones—those that weren't so good—the equipment that was too light, or heavier than it needed to be—all go to make up a seasoned, well-balanced materials handling organization—people that can give a dependable conveyer service to both light and heavy industry.

Mathews Engineers have been dealing with conveying problems for nearly 50 years. They have the stuff of which reputations are made—good, solid experience. There is no substitute for it.

The benefit of this experience, and the facilities of three modern plants are available to American and Canadian Industry. Your handling problem is our business. Your Mathews Engineer would like to tell you about Mathews Conveyer Systems, and the smooth, continuous flow of materials which they create.

MATHEWS CONVEYERS

GENERAL OFFICES . . . . . *Mathews Conveyer Company*
ELLWOOD CITY, PENNSYLVANIA

PACIFIC COAST DIVISION . . *Mathews Conveyer Company West Coast*
SAN CARLOS, CALIFORNIA

CANADIAN DIVISION . . . . . *Mathews Conveyer Company, Ltd.*
PORT HOPE, ONTARIO

Engineering Offices or Sales Agencies in Principal American and Canadian Cities

to the present shop, the building will provide one main aisle 60 ft wide and one side aisle 30 ft wide, both serviced with heavy duty traveling cranes. It is estimated that 150 tons of structural steel will be required and modern lighting, heating and ventilating systems will be featured. The new building is expected to be completed for operation within nine to ten months. This addition, coupled with a modern research laboratory, recently completed at a cost of about $125,000, will make the Canton plant one of the best equipped iron foundry and roll manufacturing plants in the world.

United also has plants in Youngstown and Akron, Ohio; Pittsburgh, Vandergrift, and New Castle, Pa.; Aurora, Ind., and Wilmington, Del.

ALCOA ESTABLISHES NEW ROLLING DIVISION

▲ A new division for the rolling of magnesium sheet will be established by Aluminum Co. of America at its New Kensington, Pa., works in the near future.

This new division has been established because of greatly increased demand for magnesium sheet in airplane construction and other phases of the national security program, the announcement said.

Magnesium rolling operations were conducted at the New Kensington works for a number of years in times past, but were discontinued in 1947 because of the sharp drop in demand for magnesium sheet after World War II. Sufficient orders are now assured to make possible the establishment of this operation on a developmental basis.

CUTLER-HAMMER, INC. OPENS DAYTON OFFICE

▲ The opening of a new sales office at 410 West First St., Dayton, Ohio, is announced by Cutler-Hammer, Inc. The office has been opened to meet the expanding need for Cutler-Hammer motor control and allied electrical apparatus in the Dayton area.

P. L. Erickson, widely known Cutler-Hammer sales representative in that area, manages the office as a branch of the company's Cincinnati district office.

FARREL® BUILDS LARGEST NONFERROUS ROLLING MILL FOR CONNECTICUT BRASS PLANT

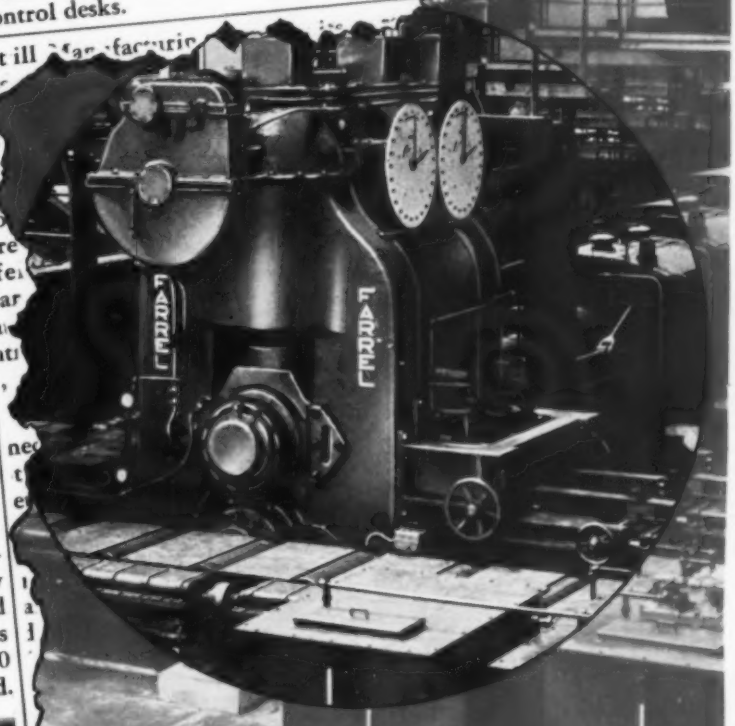
Installation At Scovill Includes Unique Mechanized Handling Equipment

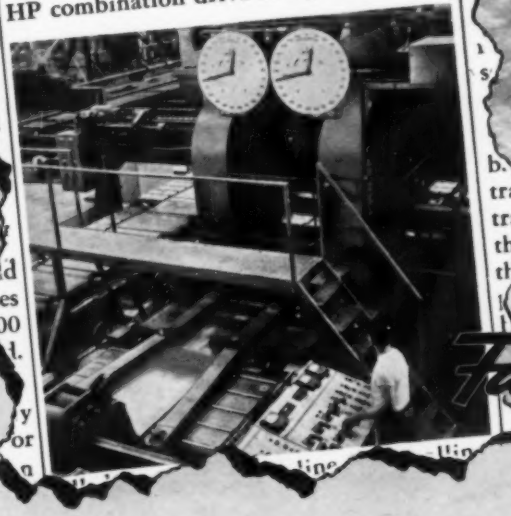
A new line of brass rolling mill equipment, installed at Scovill Manufacturing Company, Waterbury, Connecticut, has, at its starting end, a breakdown mill built by Farrel-Birmingham. This two-high 30" x 36" giant is the largest mill known to have been manufactured for the nonferrous metals industry.

Completely mechanized handling equipment, also engineered by Farrel-Birmingham, enables two operators to manipulate the bar on both sides of the mill and also regulate roll speed and gauge, all from two control desks.

The system for handling the ton-weight bars employs vacuum pilers and unpilers traveling over the entry, delivery and transfer tables. The bars are lifted from the transfer table to the entry table of the mill where a hydraulic sticker assures positive entry of each bar into the roll bite. After the pass, a kick-off device removes the bar to one of the transfer tables. From the transfer tables, the bars are stacked by vacuum pilers and later returned by chain transfer to the entry side of the mill for a succeeding pass, or delivery to the annealing oven.

The mill itself, which is proportioned for great strength, has double motor screwdown, equipped with a magnetic clutch that provides independent operation of either screw or simultaneous adjustment of both. Dial indicators show gauge readings in both thousandths and fractions of an inch. Universal spindles connect the mill rolls to the Farrel 2,000 HP combination drive and pinion stand.





For more complete details of this unique installation, write for a copy of Bulletin 31-M-493.

FARREL-BIRMINGHAM COMPANY, INC.
ANSONIA, CONNECTICUT

Plants: Ansonia and Derby, Conn., Buffalo, New York
Sales Offices: Ansonia, Buffalo, New York, Akron, Chicago, Los Angeles, Houston

Farrel-Birmingham®

MANUFACTURERS OF ROLLS AND HEAVY MACHINERY FOR THE RUBBER, PLASTIC, METAL, PAPER, SUGAR AND OTHER INDUSTRIES

FB-572

HOT ACID VS. "KARBATE" IMPERVIOUS GRAPHITE

WHEREVER metals are cleaned, plated or coated, "Karbate" impervious graphite equipment is an ideal material for cooling, conveying, pumping or storing the corrosive fluids involved.

"Karbate" pipe, fittings, valves, plate heaters, steam jets, pumps, tube-bundle heat exchangers, cascade coolers and related equipment are immune to attack by most commercial chemicals. This equipment is particularly well adapted to handling pickling solutions . . . Parkerizing and Bonderizing baths . . . nickel, copper, tin and zinc plating solutions . . . and the Alumilite and Alzek processes.

"National" carbon brick are the time-tested standby in handling nitric-hydrofluoric acid solutions . . . such as are used in the pickling tanks shown above. For complete information on both "Karbate" impervious graphite, and "National" carbon brick, write to NATIONAL CARBON DIVISION, Union Carbide and Carbon Corporation, Department IS.

These products sold in Canada by Canadian National Carbon Company, Ltd., Toronto 4

ADVANTAGES OF "KARBATE" IMPERVIOUS GRAPHITE

- RESISTS THE ACTION OF ACIDS, ALKALIS AND OTHER CHEMICALS
- HIGH THERMAL CONDUCTIVITY
- RESISTANT TO MECHANICAL SHOCK
- IMMUNE TO THERMAL SHOCK
- EASY TO MACHINE AND INSTALL
- LIGHT IN WEIGHT

The terms "Karbate", "National" and "Eveready" are registered trade-marks of

NATIONAL CARBON DIVISION
UNION CARBIDE AND CARBON CORPORATION
30 East 42nd Street, New York 17, N. Y.
District Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco
Foreign Department: New York, U. S. A.

Personnel News...

John F. Black has joined Youngstown Sheet and Tube Co. as assistant general superintendent of the steel plant at Indiana Harbor works. Mr. Black is a native of Enid, Okla., attended public schools there, then went to the United States Naval Academy. He later took courses at Johns Hopkins University and from a correspondence school. In 1925 he entered the steel business as a shipyard pipefitter with Bethlehem Steel Co. He held several line and supervisory positions which gave him a broad knowledge of steel mill practice. In 1941 he joined Atlas Steel Co., Ltd., at Welland, Ontario, Canada as fuel engineer; advanced to assistant works manager and in 1947 became plant manager of the Wickwire plant of Colorado Fuel and Iron Corp. at Buffalo, N. Y. Mr. Black is first vice president of the Association of Iron and Steel Engineers.

L. A. Lambing was named general superintendent of J&L's Pittsburgh works. Mr. Lambing joined J&L in September, 1924 as assistant superintendent of open hearth and bessemer at Aliquippa works. He was later promoted to superintendent of open hearth and bessemer at Aliquippa works, and in 1937 he was transferred to Pittsburgh works as superintendent of open hearth and bessemer. He has served as assistant general superintendent of Pittsburgh works since July, 1948.

Arno L. Billeter was named general superintendent of the Irvin works of Carnegie-Illinois Steel Corp., Dravosburg, Pa. Mr. Billeter attended Kirksville State Teachers College and Colorado State University. He began with Carnegie-Illinois in 1919 as a foreman in the annealing department of Gary sheet mill at Gary, Ind., and was transferred to Irvin works as superintendent of the cold reduction department in 1937. Appointed in 1944 as superintendent of the Carnegie-Illinois plant at Vandergrift, Pa., he returned to Irvin works in 1947 as assistant general superintendent.

George S. Ashmun was appointed general superintendent of the Jones and Laughlin Steel Corp.'s Otis works, Cleveland, Ohio. **John M. McColloch,** formerly superintendent of the finishing divisions at Otis works, will succeed Mr. Ashmun as assistant general superintendent. Mr. Ashmun joined Otis Steel Co. in March, 1916. He served as superintendent of the Lakeside plant from 1925 to 1928. He was assistant to the vice president and general manager prior to the acquisition of Otis Steel Co. by J&L in 1942. Since 1942, he has been assistant general superintendent of Otis works. Mr. McColloch came to the Otis Steel Co. in December, 1932, as superintendent of the sheet mill department and for several years has been superintendent of finishing divisions.

John F. Agerter has been appointed superintendent of blast furnaces at the Indiana Harbor, Ind., works of Youngstown Sheet and Tube Co. He succeeds **Clyde M. Horan** who was transferred to Youngstown as superintendent of blast furnaces at the Campbell works. After graduating from public schools in his native city of Lima, Ohio, Mr. Agerter worked two years in the Lima Locomotive machine shop where he had worked during summer vacations while attending high school. He later attended Case Institute of Technology, receiving a bachelor of science degree in mechanical engineering. Mr. Agerter entered the steel business at the age of 22 as a laborer for Cambria Steel which later became part of Bethlehem Steel. He worked for a short time as sintering plant foreman, then as blast furnace labor foreman, then as blower and later as metallurgical assistant. In 1929 he entered the service of Youngstown Sheet and Tube Co. as efficiency engineer at the Campbell works coke plant. A few months later he began his extended career in the blast furnace department as a substitute blower. In 1930 he became a blower, in 1933 a furnace practice man; 1939 general foreman of blast furnaces and five years later assistant superintendent of blast furnaces at the Campbell works. He held this position until his recent promotion.

Albert J. Berdis has been appointed assistant general superintendent of Irvin works of Carnegie-Illinois Steel Corp., and **Albert T. Reichenbach** succeeds him as superintendent of the Vandergrift plant of the company, it was announced recently by this United States Steel subsidiary. Mr. Berdis was graduated from Purdue University with a degree in engineering. He started with Carnegie-Illinois in 1929 as a fuel engineer at

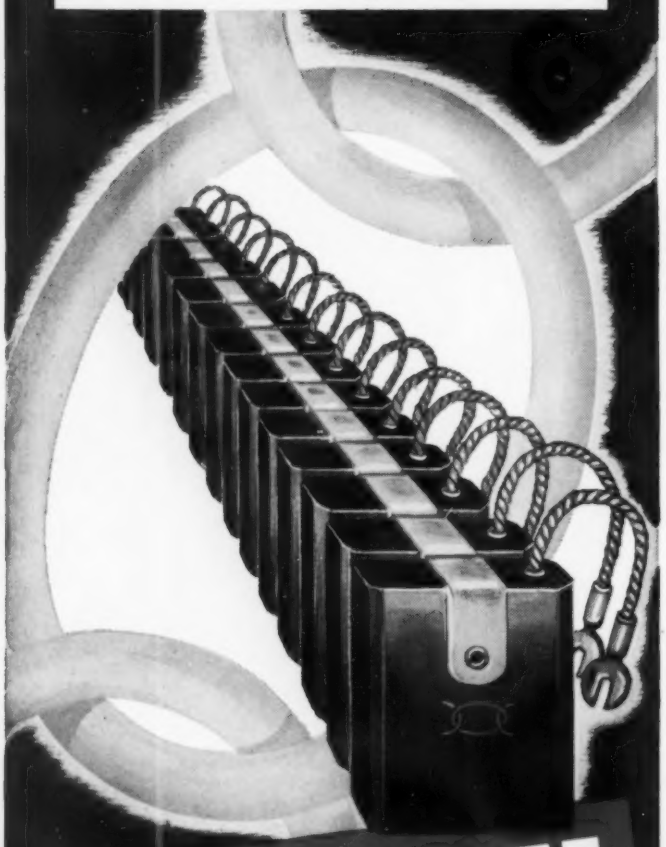
JOHN F. BLACK

L. A. LAMBING

ARNO L. BILLETER

GEORGE S. ASHMUN

Link YOUR COMMUTATION TO THE RIGHT
MORGANITE
brush grade



MORGANITE
CARBON BRUSHES

The wide range of MORGANITE brush compositions is an important aid when selecting a brush to meet a specific motor or generator operating condition. Equally helpful is the wide experience of MORGANITE engineers who will gladly assist in determining your proper brush grade.

Morganite
INCORPORATED
LONG ISLAND CITY 1, NEW YORK

Manufacturers of Morganite Self-Lubricating Carbon Specialties including Seals, Rings, Valves, Slides, Bearings, etc., and Carbon Piles

Gary works, Gary, Ind., and was transferred to the company's general office in Pittsburgh in 1935 as electrical engineer. In 1938 Mr. Berdis was named appropriation control engineer at Irvin works. He became assistant to the general superintendent there in 1945 and was named superintendent at Vandergrift two years later. Mr. Reichenbach was graduated from Carnegie Institute of Technology with a degree in metal-

ALBERT J. BERDIS

lurgical engineering. He was first employed by Carnegie Steel Co. in 1918, and has since held various positions in the metallurgical and operating departments in Pittsburgh district plants of Carnegie-Illinois Steel Corp. At the time of his appointment he was superintendent of the galvanizing department at Irvin works.

F. R. Burnette has been appointed assistant vice president-engineering of United States Steel Corp. of Delaware. In this newly created position, Mr. Burnette will have special duties in connection with the future construction programs of United States Steel. Mr. Bur-

F. R. BURNETTE

nette attended Ohio Northern University where he was graduated in 1910 with a degree in civil engineering. Before going to college, he had been employed at Farrell works of Carnegie Steel Co. as a laborer, machine operator and foreman, and after graduation returned to U. S. Steel as an inspector and estimator at the Illinois Steel Co. In 1912 he accepted employment with Aluminum Co. of France and Aluminum Co. of

America at Baden, N. C., returning to U. S. Steel in 1916 as engineer of coke works for the American Steel & Wire Co. at Cleveland. He was made assistant chief engineer of the company in 1937 and transferred to Carnegie-Illinois in 1939, where he was successively construction superintendent and assistant chief engineer.

William C. McConnell, a sales engineer for Reliance Electric and Engineering Co. in the Pittsburgh district for the past two years, has been named branch manager of a new Charleston, W. Va., office, located at 1205 Kanawha Blvd., East. Mr. McConnell joined Reliance in 1947 following graduation from the University of Michigan, where he specialized in engineering.

John H. Elliott was appointed assistant general manager of operations of Carnegie-Illinois Steel Corp., Pittsburgh, Pa. Mr. Elliott is a native of Elwood, Ind. He studied engineering at the University of Pittsburgh and started with U. S. Steel in 1919 in the engineering department of the former American Sheet and Tin

JOHN H. ELLIOTT

Plate Co. in Pittsburgh. He was transferred to Shenango works as combustion engineer in 1926 and was promoted through the ranks there to become assistant superintendent in 1937. Later that year, he was transferred to Irvin works as superintendent of the tin finishing division. He was named assistant general superintendent of the plant in 1940 and became general superintendent in 1947.

William F. MacDonald was elected president of E. F. Houghton & Co., Philadelphia, Pa. Mr. MacDonald will temporarily continue to hold his present office as treasurer, succeeds **Major Aaron E. Carpenter,** who was elected chairman of the board of directors.

H. Walter Regensburger has been appointed chief engineer of the general engineering department of Link-Belt Co., Chicago, Ill., to succeed **Harry L. Strube,** who has retired after many years' service in sales and executive engineering capacities. Assisting Mr. Regensburger will be **Charles M. Young, Jr.,** in the capacity of chief developmental engineer, and **Harold F. Watson** as chief standards engineer. Both men have been identified with the general engineering department since it was first organized in Philadelphia in 1946, and both were previously members of the Philadelphia plant engineering department.

DE LAVAL VERTICAL DRIVE REDUCERS

A complete line of De Laval vertical speed reducers, in both single and double reductions, is available for driving agitators, mixers, and many other types of vertical shaft equipment.

If vertical drives are your problem, consult De Laval.

*This single reduction De Laval Worm Gear Reducer is available with many standard gear ratios and is but one of the 93 sizes and types of standard De Laval Worm Gear Speed Reducers.

*ONE OF 93

SEND FOR CATALOG 50-11-R.

Worm Gear Division

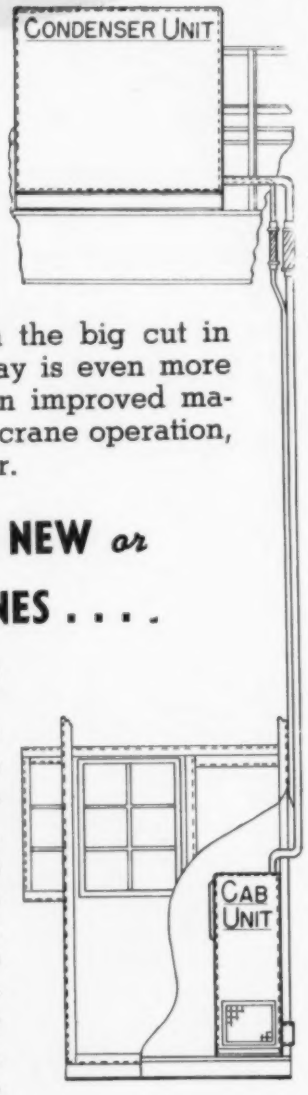
DE LAVAL

De Laval Steam Turbine Co., Trenton 2, N. J.

TURBINES • HELICAL GEARS • WORM GEAR SPEED REDUCERS • CENTRIFUGAL PUMPS
CENTRIFUGAL BLOWERS AND COMPRESSORS • IMO OIL PUMPS

LINTERN Aire-Rectifiers

SOON REPAY OUTLAY... PROVIDE MANY LASTING BENEFITS



By providing normal, healthful working conditions, Lintern Aire-Rectifiers have always paid out in dollars and cents. But now — with the big cut in over-all costs, the outlay is even more quickly paid back — in improved material handling, better crane operation, and less labor turnover.

3 MODELS FOR NEW *or* EXISTING CRANES . . . .

These three models come in the new "split" design and offer many economies. Due to elimination of troublesome, clumsy air ducts, installation has been greatly speeded up. Flexible in location, the new models are easily and quickly installed on existing cranes as well as on new ones. The three sizes meet all needs and allow us to give you the lowest cost unit to meet your individual needs. In addition, we have a new self-contained Aire-Rectifier for location in cab where conditions permit its use.

May we explain the features and economies of the Aire-Rectifier as applied to your particular conditions? Ask for Bulletin A.C. 4912.

THE LINTERN CORPORATION

54 LINCOLN AVENUE **BEREA, OHIO**

Albert T. Lawson was elected to the newly-created position of vice president, general services, Jones and Laughlin Steel Corp., Pittsburgh, Pa. Mr. Lawson joined Jones & Laughlin Steel Corp. in 1915. Since that time he has successively held the position of chief industrial engineer at the Monongahela Connecting and

ALBERT T. LAWSON

Aliquippa & Southern Railroads, Vesta Coal Co. (Marine Ways), and at Aliquippa works. In 1946 he was promoted to the position of chief industrial engineer for J&L, and since August, 1947, he has been general superintendent of Pittsburgh works.

James D. Rollins has been promoted to assistant chief engineer of Carnegie-Illinois Steel Corp., Pittsburgh, Pa. **Norman C. Michels** has been appointed planning engineer to succeed Mr. Rollins, and **Harry C. Hunter** has been named contract engineer. Mr. Rollins has been associated with U. S. Steel since 1934 when he was first employed by the American Sheet & Tin Plate Co. as a draftsman and estimator. In 1937 he was transferred to Gary, Ind., where he attained the position of chief engineer of Gary steel works. In 1948 he returned to Pittsburgh as planning engineer, the position he

JAMES D. ROLLINS

held at the time of his present appointment. Mr. Michels, a graduate of Purdue University, started his career with Carnegie-Illinois in 1941 as a special engineer in the general offices. He left the corporation in 1947 to become assistant to the president of a clay

products company. A graduate of Iowa State College, Mr. Hunter first joined U. S. Steel as a field engineer for the American Bridge Co. He has held various engineering posts in American Bridge and Carnegie-Illinois and was general supervisor of construction at Gary steel works when appointed to his present position.

Van H. Leichliter has been named assistant vice president, operations, for American Steel and Wire Co., Cleveland, Ohio. Mr. Leichliter, who was employed in

VAN H. LEICHLITER

the Worcester, Mass., metallurgical laboratory of the wire company in February, 1930, presently is general superintendent of the company's South works in Worcester.

Frank F. Cambest was named assistant general superintendent of Jones and Laughlin Steel Corp.'s

FRANK F. CAMBEST

Pittsburgh works. Mr. Cambest was formerly superintendent of blooming and rolling mills at Pittsburgh works. He began his services with J&L in the metallurgical department in 1919.

R. A. Roosevelt has been named sales manager of Eriez Manufacturing Co., Erie, Pa. He replaces **George R. Wellmon**, resigned.

Curtner B. Akin has been named manager of the mechanical tubing department of National Electric Products Corp., Pittsburgh, Pa.

Richard Aubrey has been appointed assistant to the

Browning Mill Type Cranes are built in accordance with A. I. S. E. specifications. They incorporate the types of motors and controls on which your mill or industry has standardized. This flexibility adapts your VRB crane *perfectly* to your needs. Only the finest materials are employed. Browning heavy duty cranes meet the most rigid demands and satisfy the most critical users. Our design, placing plenty of strength wherever needed, is the outgrowth of 48 years' experience in the crane industry.

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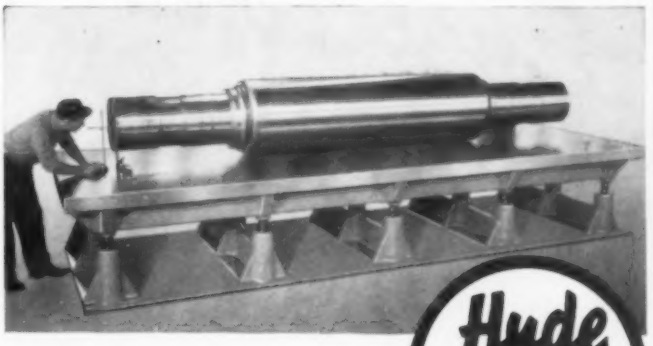

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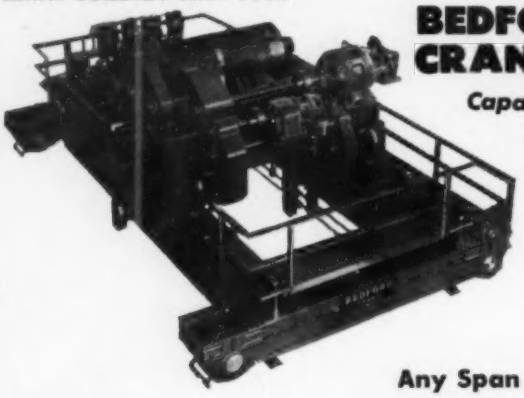

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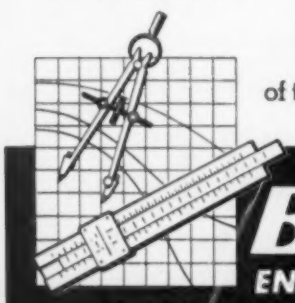
- Differential Pressure Constant-Flow Oil Valves
- Steam-Oil Pressure Ratio Regulator
- Bloom Time Cycle Reversal Systems for Open Hearth Furnaces



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BLOOM ENGINEERING CO., INC.

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vice president in charge of operations, as liaison man on tubular steel products for Kaiser Steel Corp., Fontana, Calif.

RICHARD AUBREY

Robert C. Madden, superintendent of the metallurgical department for Kaiser Steel Corp., Fontana, Calif., has been named division superintendent of rolling mills. **Ernest F. Donatic,** superintendent of electrical maintenance, becomes division superintendent of plant service departments. **Glenn Thompson,** assistant superintendent of electrical maintenance, becomes superintendent of that department. **Bernard A. Shrive,** chief electrician, electrical maintenance, has been advanced to assistant superintendent. **William Depew,** assistant superintendent, has been made superintendent of the metallurgical department.

J. M. Spangler, former director, vice president and general manager of National Carbon division of Union

J. M. SPANGLER

Carbide and Carbon Corp., has been appointed president of the division after thirty-five years of service.

Charles M. Kay has been appointed division superintendent of steel works of American Steel & Wire Co.'s South works in Worcester, Mass. After 18 months service at Donora, Pa., he was promoted to senior observer, before becoming works metallurgist at the Allentown, Pa., plant. In February, 1943, he was named division metallurgist at South works, and a year later was

transferred to the office of the manager of metallurgy in Cleveland, Ohio, for a short period. He returned to South works as assistant division superintendent of the steel works in August, 1945.

Umbert F. Corsini has been named general superintendent of American Steel & Wire Co.'s South works in Worcester, Mass. After several promotions, Mr. Corsini moved into the operations end of steel making by becoming a student apprentice in the open hearth and rolling mill in October, 1935. Three years later he was made assistant general foreman of the rolling mill, and became assistant superintendent of the open hearth department in February, 1941. Two years later he was promoted to assistant division superintendent of the steel works, and became division superintendent of steel works in August, 1945.

Erb Gurney has been appointed manager of sales, forgings, castings, and ordnance, Bethlehem Steel Co. Mr. Gurney, a graduate from Oregon State College, came to Bethlehem in 1927 and has worked in various capacities in the operating and sales departments.

Arthur Grund, for nearly 14 years turn foreman at the blooming mill, has been appointed assistant superintendent of rolling mills at the Indiana Harbor, Ind., works of Youngstown Sheet and Tube Co.

M. L. Manning was appointed development engineer of Pennsylvania Transformer Co. Mr. Manning's industrial experience includes motor and generator design work (1928-1932) with the Westinghouse Electric Corp.; transformer design and research engineering with the Westinghouse Electric Corp. (1936-1942); and 4½ years association with Kuhlman Electric Co. as chief engineer (1945-1949).

Boris Volgovskoy was named as head of the substation and regulator department of Pennsylvania Transformer Co., Pittsburgh, Pa. Prior to his affiliation with Pennsylvania Transformer Co., Mr. Volgovskoy was with the switchgear division of the Allis-Chalmers Manufacturing Co., Milwaukee, Wis., as section engineer in charge of metal enclosed draw-out switchgear, switchboards, and mercury arc rectifier controls.

John Horth has been named manager of the St. Louis, Mo., office of the De Laval Steam Turbine Co.

E. K. Brown formerly chief engineer of the Torrington Co., needle bearings division has been appointed director of research for Torrington Co. This department will be expanded to encompass research work in the design and development of new products, as well as the study of methods and improvement of all products currently manufactured by this company. **B. T. Virtue** will succeed Mr. Brown as chief engineer of the needle bearings division.

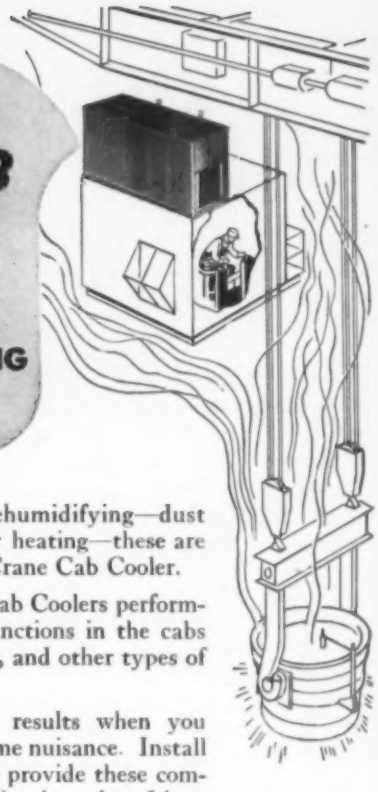
Melvin O. Monsler was named sales manager of the P&H welding division of Harnischfeger Corp., Milwaukee, Wis. Mr. Monsler has been associated with Harnischfeger for 12 years, serving for four years as assistant sales manager of the welding division and one year as welding product service engineer.

J. Sterling Davis has been elected treasurer and a member of the board of directors of National Electric Products Corp., Pittsburgh, Pa.

James H. Binger has been elected vice president and general manager of the Belfield Valve division of Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.

DRAVO CRANE CAB COOLERS

PERFORM EVERY AIR CONDITIONING FUNCTION



Cooling—fume removal—dehumidifying—dust filtering—ventilating—winter heating—these are the functions of the Dravo Crane Cab Cooler.

You will find Dravo Crane Cab Coolers performing these air conditioning functions in the cabs of soaking pit, ladle, stripper, and other types of hot-metal cranes.

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THEY ARE PRODUCED by a skilled personnel, sensitive to your desires, working in an environment of enthusiasm and teamwork.

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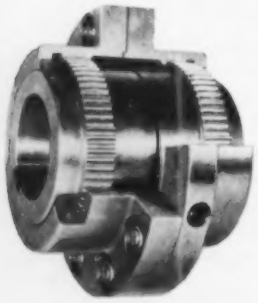

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Ernest E. Brayshaw has recently become affiliated with Continental Foundry & Machine Co. in a sales capacity connected with the firm's rolling mill and heavy machinery products. Before coming to Continental Mr. Brayshaw served as works manager for

ERNEST E. BRAYSHAW

Southwest Steel Rolling Mills, Los Angeles, Calif. For eleven years prior to this, he was connected with Carnegie-Illinois Steel Corp. at Clairton, Pa., works during which time he served as assistant division superintendent.

Robert G. Bryan has been appointed Chicago district steel engineer for Republic Flow Meters Co. with offices at Republic's Chicago factory. Mr. Bryan graduated

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from Carnegie Institute of Technology and served in the fuel engineering department of Carnegie-Illinois Steel Corp.

James F. Dailey was named purchasing agent of National Tube Co., Pittsburgh, Pa. He succeeds **G. Glenn Goe** who has retired after 49 years service. Mr. Dailey was born in Steubenville, Ohio. He attended Steubenville High School and the University of Pittsburgh. He started with National Tube in 1942, in the accounting department. The following year he was transferred to the purchasing department, as office manager, and in 1947 he was appointed assistant purchasing agent.

Obituaries

J. R. Robinson, 84, died March 2 in Ellwood City, Pa., Hospital. Mr. Robinson was president of Robinson Ventilating Co., Zelienople, Pa.

J. Belmont Mosser, 64, industrialist and past president of Kiwanis International, died February 13. Mr. Mosser was vice president and general manager of the Speer Carbon Co., vice president of International Graphic & Electrode Corp.

Elmore L. Ross died February 20. Mr. Ross was Pittsburgh district manager of the Monarch Machine Tool Co. of Sidney, Ohio. He served his apprenticeship at the National works of the National Tube Co. of McKeesport and left to join the Westinghouse Electric Corp., where he assisted the late Dr. Frank Conrad in the development of radio. Later, he was with the Manning, Maxwell & Moore Co. and the Arch Machinery Co.

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INDUSTRIAL GEAR MFG. CO. CHICAGO
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SERVE THE STEEL INDUSTRY
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"IG" DUROCASE GEARS are made to stand the gaff. Deep case hardening does it! Write for details.
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Expansion and contraction of metals during *Off* and *On* periods compress links. This fluctuation causes loose contacts and oxidation in other fuses, which finally result in excessive heating and unnecessary blows. WARE HI-LAG construction keeps contacts permanently tight, thus insuring low resistance and longer fuse life.

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INGOT MOLD COATING

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for Sludge elimination, Greater B.T.U. Release and Decreased Oil Consumption.

Now being used in millions of gallons of fuel oil.
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All piping needs quickly filled ...with one order to CRANE

EXTRA BODY STRENGTH ... EXTRA HOLDING POWER IN COMPACT DESIGN

Crane Forged Steel Ground Joint Unions are exceptionally strong, tough and durable. Ample reinforcement at points subject to greatest stress makes them particularly suitable for high pressures and temperatures—and other severe services on steam, oil, water, air, or gas lines.

Crane precision-machined union seats—steel to steel or steel to brass—hold pressure easily. No gasket is required. Furnished all cadmium plated or with cadmium plated union ring only. This feature provides resistance to rust, and acts as a permanent and effective lubricant. Extreme accuracy of Crane machining permits interchangeability of all parts. For a complete selection of dependable unions, see your No. 49 Crane Catalog, p. 183.

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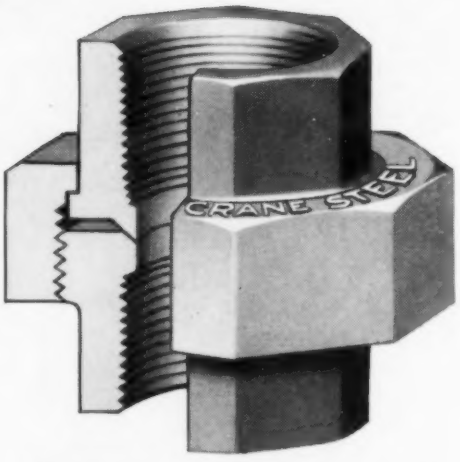

WORKING PRESSURES: 2000 pounds water, oil, or gas. Steel to Steel Seat—585 pounds steam or hot oil, 900° F. Brass to Steel Seat—600 pounds steam or hot oil, 550° F. Sizes: ⅛ to 3 in.

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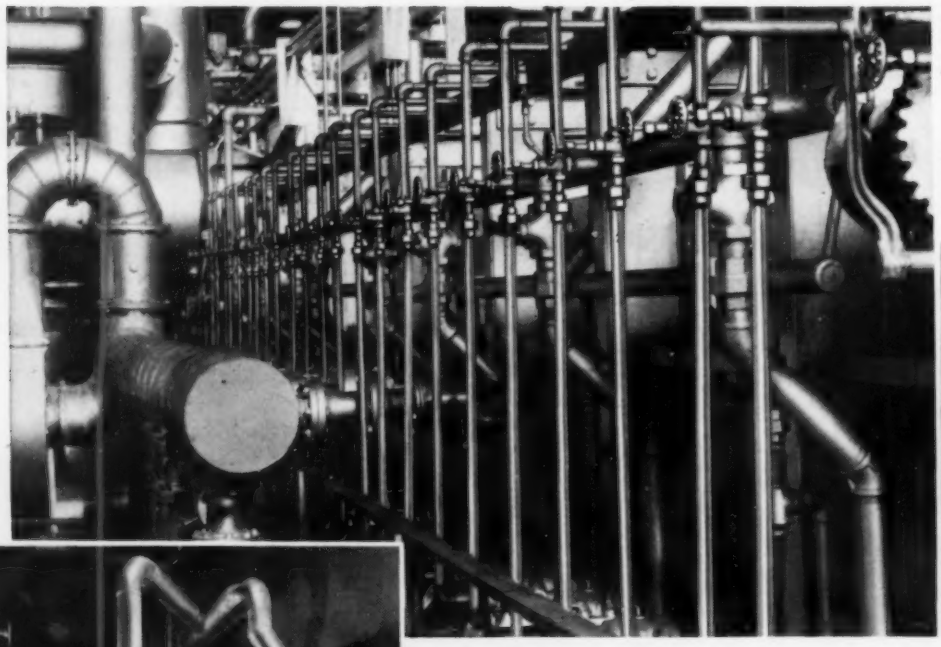

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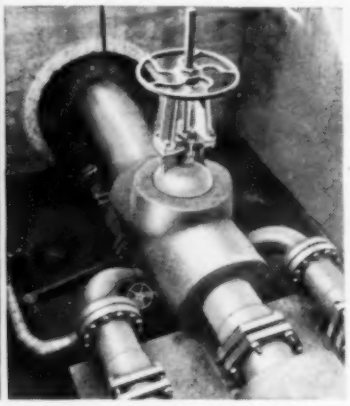

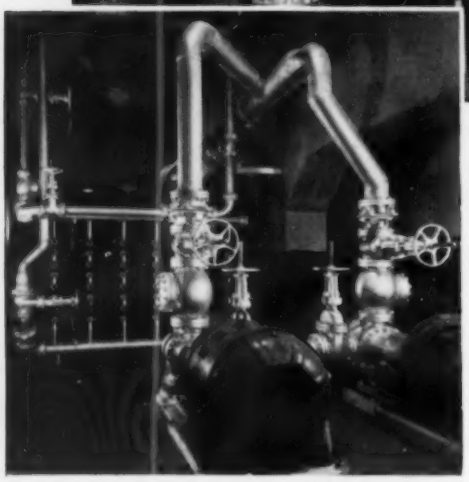

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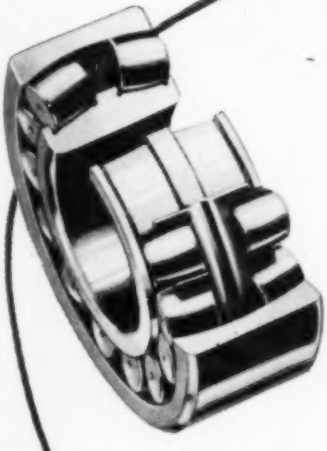

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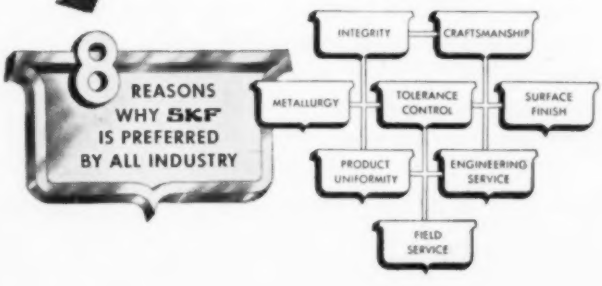
High speed coiling of strip aluminum alloys ¼-inch thick and 90-inches wide is a tough job that jolts bearings to the limit. Yet they've got to run smoothly and without increase in friction. That's why Treadwell Engineering Company uses SKF Spherical Roller Bearings in all locations on the pinch rolls and coiling rolls. Because of their undiminished high capacity, due to inherent rolling self-alignment, SKF Spherical Roller Bearings can be fitted into the limited space available. This same alignability prevents concentration of shaft stresses . . . enables the bearings to run cool at high speeds. SKF Engineers will be glad to work with you in selecting the SKF bearing that helps heavy machinery perform with the dependability that builds acceptance for it. SKF Industries, Inc., Philadelphia 32, Pa. 7048



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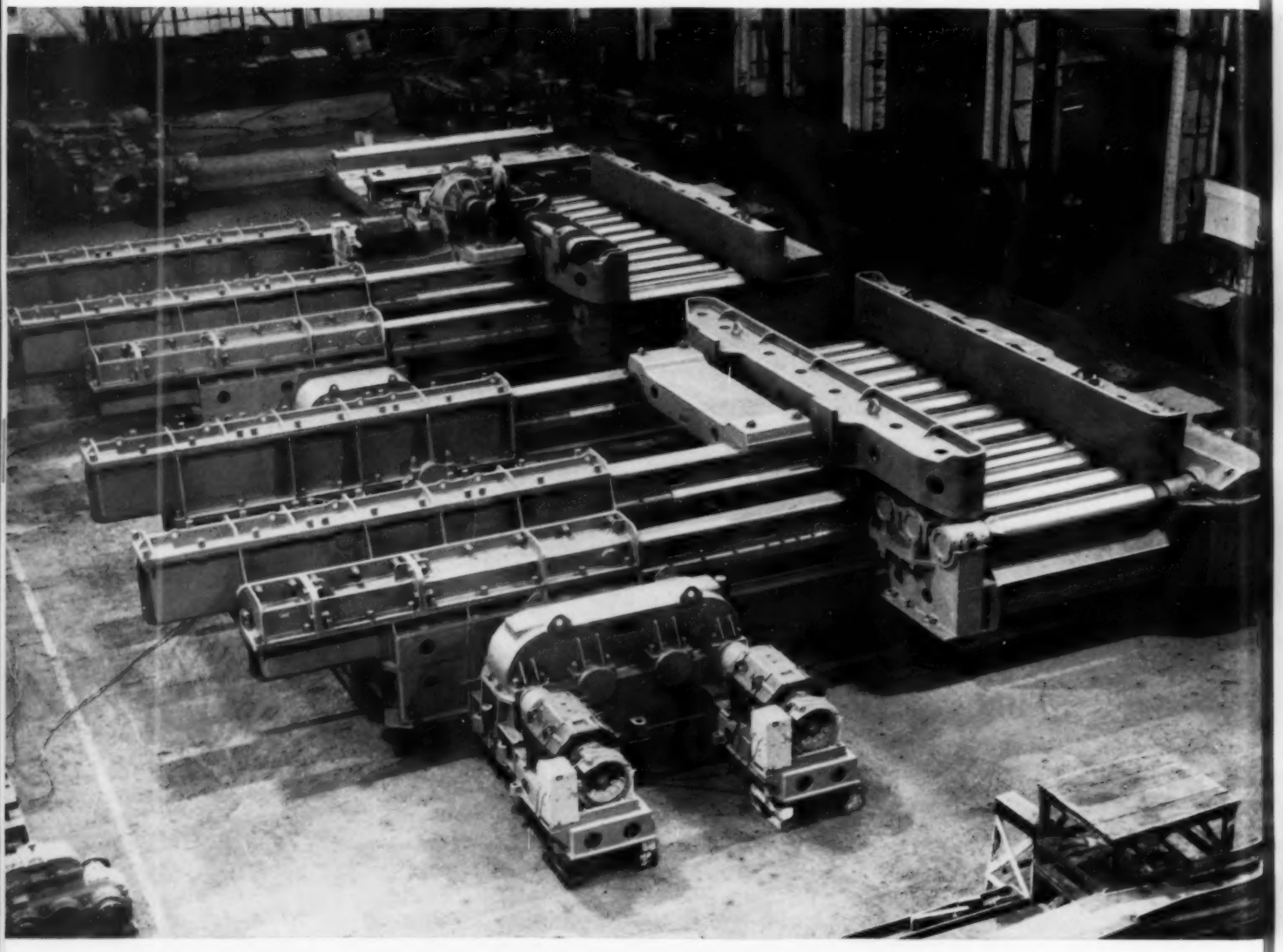

Shop view of 40″ Blooming Mill Manipulator and Mill Tables, furnished with a Morgan 40″ Blooming Mill, having Twin Motor Drive. Manipulator is of the overhead type, electrically driven with retractable heads so the table rollers can be removed without dismantling the manipulator heads.

Table girders are of cast steel box section type with integral oil trough on drive side. All gears are totally enclosed, operating in oil, and have hardened teeth. All bearings are of anti-friction type, lubricated through a centralized motor operated system.

Your inquiries appreciated.

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Equipment News...

McLOUTH STEEL PLANT CONTAINS FAST OPERATING MILL DRIVES

▲ McLouth Steel Corp.'s new plant at Trenton, Mich., which began operations this last December, contains some of the fastest-operating mill drives in the country. These drives are a part of approximately $3,000,000.00 worth of electrical equipment which has been built by General Electric for McLouth. The complete order includes electrical equipment for the blooming and slabbing mill, a slab shear, a crop shear, a pickling line, three slitting lines, and a shearing and recoiling line. In addition, all generating and control equipment has been supplied by G-E as well as all the switchgear for plant substations and motor control rooms.

With a reversing cycle that allows it to shift, a 20,000-lb slab from base speed to base speed in less than 1½ sec, the blooming and slabbing mill is reported to have the highest speed reversing cycle in the industry. The 40-in. mill, using a 6000-hp G-E twin drive consisting of two 3000-hp, 40/100-rpm, 600-volt motors each directly connected to a work roll, has an every ingot torque rotating of 1,770,000-lb ft and a maximum torque rating of 2,160,000-lb ft. In conjunction with the main drive a 750-hp, 150/450-rpm, 600-volt G-E reversing motor will provide the edger drive. Both the main drive and the edger drive have individual amplidyne control that allows separate operation of the generator voltage for the main drive and for the edger drive, and also provides separate control of the motor fields. Additional auxiliaries located on and around the mill provide 1325-hp of amplidyne controlled d-c drive and 1000-hp of constant voltage a-c drive.

Because of the unusually long passes for a mill of this type, three 1750-kw generators driven by a 7400-hp synchronous motor with a power factor regulator are being used to supply the blooming mill instead of the usual induction motor driven flywheel motor-generator set. During the last pass, the metal is in the mill for approximately 14 seconds and emerges as a plate ¾-in. thick, 36-in. wide, and 244-ft long. The plate is then transferred on tables to a reversing hot strip mill for further reduction into hot rolled strip.

The slab shear, driven by two 250-hp d-c motors, and the crop shear, driven by two 150-hp d-c motors, are both individually G-E amplidyne controlled, and reach cutting speed in unusually short times. The slab shear, designed to cut blooms up to 12-in. by 12-in. and stainless steel slabs up to 6-in. by 36 in. reaches cutting speed in $^{8}/_{10}$ sec. The crop shear, which crops front and tail ends of the plate, catching the tail end on the fly, before going into the reversing hot-strip mill will cut stainless steel up to 1¼-in. by 42-in., and reaches cutting speed in the amazingly short time of $^{35}/_{100}$-second.

In addition to the blooming mill and the shears, the pickling line, the three slitting lines, and the recoiling line will also use complete amplidyne control. The pickling line, using the newest type of amplidyne control in which complete start-stop control is provided by amplidynes, will use no motor operated rheostats to operate the 490-hp of d-c drive needed to handle the unusually heavy amount of material to be passed through it. The three slitting lines will have 250-hp of amplidyne controlled drive on each line, and the shearing and recoiling line which can process or shear the strip will use 620-hp of amplidyne controlled drive. In addition, it is reported, the pickling line, the slitting lines, and the recoiling line will have a total of approximately 700-hp in auxiliary drives.

Complete a-c switchgear has been supplied for the 6900-volt plant substation, the blooming mill motor room, and the pickle line motor room. Also, three 480-volt, 1500-kva unit substations have been supplied for general plant use. One will be located in the blooming mill motor room, one in the hot strip motor room, and one to supply the finishing area of the plant.

Control switchgear will also include d-c metal-clad draw out units for the blooming mill motor room and the hot strip motor room. In conjunction, two 1000-kw constant voltage motor generator sets will be located in the same motor rooms.

LARGEST STEELWELD SHEAR IS COMPLETED

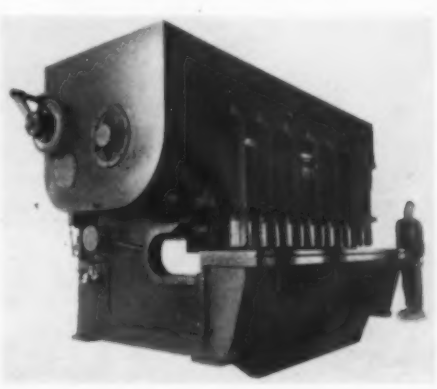
▲ The largest "Steelweld" shear built to date has just been completed by Cleveland Crane & Engineering Co. The machine has a shearing capacity of 12 ft of 1 in. steel plate. Although this is the heaviest shear, it is not the longest, for these shears have been built for cutting plate up to 18 ft-0 in.

The machine has no slides or guides for the knife to work in, because it makes use of a pivoted-blade cutting principle which is exclusive with "Steelweld" shears. The upper blade operates on two heavy pins secured to the side frames and travels in a circular path.

An outstanding feature is the exclusive micro-speed knife adjustment which makes it extremely easy and fast to change knife clearance to suit various thickness plate and thereby enable making the best possible cuts. This is done in a matter of seconds by simply turning a convenient hand crank and watching a dial indicator that shows the clearance in thousandths of an inch, and also the plate thickness that may be cut for any knife setting.

This shear cuts at the rate of 25 strokes per minute. The throat is 24 in. deep which is standard for all these shears. Both frame and blade

The new shear has shearing capacity of 12 ft of one inch plate.



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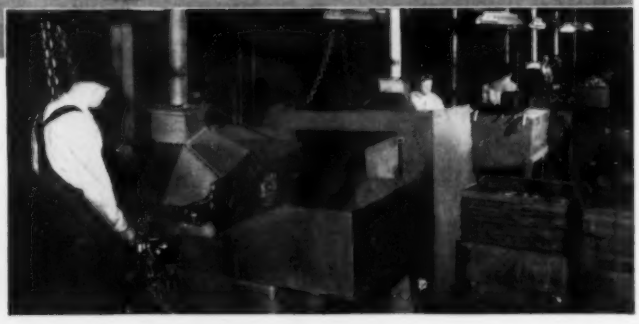
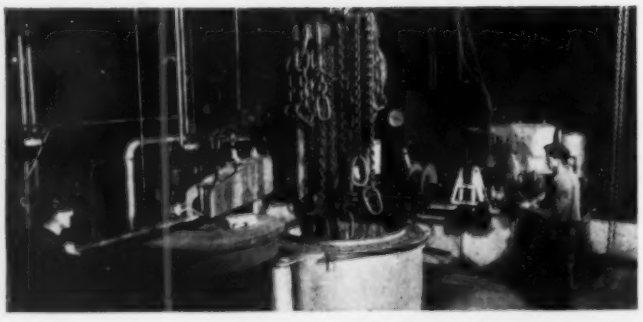
TWO U-shaped half links are electrically welded to form stress-free links, by only the most experienced craftsmen.





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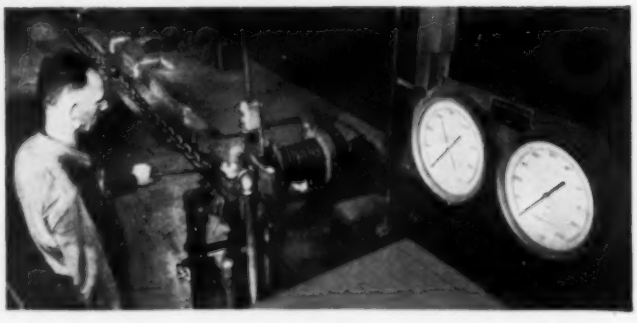
TM Alloy Chain and attachments receive a controlled heat-treatment. Never requires annealing. Resistant to shock, grain growth and work hardness.

THOROUGHLY TESTED

TM Alloy Steel Chain is subjected to gruelling tests before shipment. It has twice the working load limit of wrought iron or low-carbon steel chain of the same size.



CAREFULLY INSPECTED

Each link of every TM Alloy Steel Chain is thoroughly inspected before shipment, by experienced chain craftsmen.

See your Mill Supply Distributor or send today for your free copy of new TM Alloy Steel Chain Booklet!

S. G. TAYLOR CHAIN CO.

64-141st Street, Hammond, Indiana

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National Safety Congress

are of all-welded one-piece steel construction. The frame bed and crown are welded integral with side frames to assure permanency and provide rigidity and lifetime accuracy. The bed has ball bearing transfers to facilitate the movement of steel through the knives.

Control of the machine has been made especially easy through use of an electric foot switch that is connected to the shear by a cable to a receptacle at the front. The switch can be moved about the floor to wherever most convenient. Only an easy movement of the toe is required to operate it.

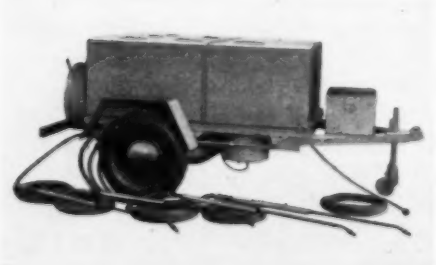
Safety was given careful attention in the design of the machine and protective features are provided throughout to eliminate all hazards as completely as possible. All rotating parts are at rear and out of the way. Knife and hold-downs are fully protected by a heavy plate-type guard.

STEAM CLEANER USED AS HEAT GENERATOR

▲ A new super-duty "Hypressure Jenny" steam cleaner designed and built to do the biggest cleaning jobs, and also for heat-transfer uses, has just been announced by Homestead Valve Manufacturing Co. As a steam cleaner, the steam cleaner is said to clean grease, grime and dirt from machinery and equipment 48 to 60 times faster than by hand methods; and even six times faster than any extra heavy-duty steam cleaner. Its 300 gal per hour capacity will operate from one to four cleaning guns. Full operating pressure is reached within two minutes from a cold start.

In less than two minutes, it can be changed over for use as a heat generator, with heat output equivalent to

Within two minutes this steam cleaner can be changed to a heat generator.



a 25 hp boiler. Change is completed by simply loosening two bolts and reversing crank arm. Unit is then ready for such jobs as heating tanks of viscous fluids such as tar or molasses, thawing frozen cars and culverts, pasteurizing, sterilizing soil, etc.

The cleaner is made in trailer mounted, portable, and stationary models. Standard equipment on all models includes one ½-in. "Hypower" cleaning gun, one 25 ft length each of ½ in. and ¾ in. vapor hose, and a choice of either gasoline engine or 1 hp electric motor. Weighing approximately 1600 lb, the unit measures 48 in. in width by 44 in. in height and varies in length from 78 in. to 132 in. depending upon the model chosen.

SELF-PROPELLED CLEANER SCRUBS PLANT FLOORS

▲ Finnell Systems, Inc., has announced a self-propelled combination Scrubber-Vac, No. 418P, for small-area buildings—for floor areas ranging from 2,000 to 15,000 sq ft.

Like Finnell's larger combination machines, the new unit applies the cleanser, scrubs, rinses, and picks up—all in a single operation. Produces clean floors in approximately one-third the time required with a conventional 15 in. or 18 in. polisher-scrubber using separate equipment for pickup, etc.

In one single operation this sweeper applies cleanser, scrubs, rinses and picks up dirt.

The new unit handles both wet and dry work. All the refinements developed by Finnell since combination machines were introduced by them in 1929 are embodied in this new machine which can be leased or purchased.

AGITATOR TAKES OUT NON-MAGNETIC MATERIAL

▲ The new Eriez non-electric agitator separator is designed to separate small amounts of non-magnetic material from large amounts of magnetic material.

The project may be the recovery of valued magnetic materials from non-magnetic waste as in the recovery of steel grindings from abrasive grit after steel billets are surface-ground. It may be the recovery of non-magnetic chemicals from fine iron or shot after ball-mill operations. Sometimes it is merely the separation of fine magnetic scrap from non-magnetic cuttings when it is desired to recover both.

The difficulty in this type of separation in the past has been the trapping of non-magnetic material among the magnetic particles, as the latter are drawn into the magnetic field. Eriez has surmounted this difficulty by effecting physical separation by agitation before the material reaches the most powerful areas of the magnetic field.

The agitator separator consists of a permanent magnetic pulley, the

EF Special Atmosphere Roller Hearth Furnace Continuously Bright Normalizing Two Strands of 27" Strip — Capacity 7200 Lbs. Per Hour.

ANNEALING STRIP STEEL *Continuously* IMPROVES THE DRAWING QUALITIES

● EF continuous annealing and normalizing furnaces subject the entire length, and width of the strip to *exactly the same* time and temperature treatment, resulting in extreme uniformity of grain size, yield point, and completeness of recrystallization;—all definite advantages for deep drawing. They tie-up a minimum amount of material in process;—usually *cost less* than batch equipment of equivalent capacity; prevent scaling; eliminate pickling; avoid the need of "rider strips," and danger of scratching.

Capacity to 28,000 lbs. or more, per hour—single or multiple strands up to 54", or wider. Send today for completely descriptive literature and treated samples.

EF

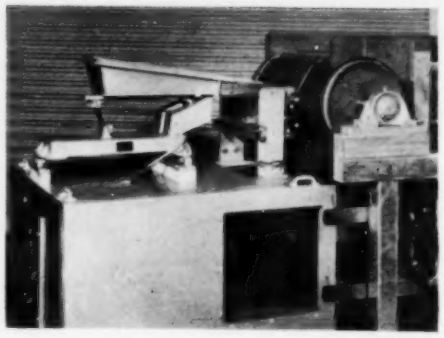
THE ELECTRIC FURNACE CO.

GAS FIRED, OIL FIRED AND ELECTRIC FURNACES FOR ANY PROCESS, PRODUCT OR PRODUCTION

Salem - Ohio

surface of which consists of alternate lengthwise "slats" of Alnico alternated with slats of non-magnetic material. A receiving chute or vibrator tray distributes the material to be separated to a non-magnetic vane assembly from which it passes to the pulley belt. The receiving chute is slightly tilted downward and attached at the forward end to the agitator feeder. The heart of the separator consists of several baffles of non-magnetic metal. Two induction arms reach over the pulley. These react to the north and south magnetic poles which cause a flutter in the vane assembly.

The agitation of the thin layer of material flowing gradually down the chute frees the particles and makes pick-up easier. As the material reaches the magnetic field of the pulley the magnetic particles "walk" end over end through the feeder into the surface of the pulley-belt, being impulsively attracted because of the alternating north and south magnetic poles of the pulley magnets. From the vane assembly the magnetic particles jump to the belt and adhere to it until carried out of the magnetic field, at which point they drop into a receptacle.



This separator will aid recovery of valued magnetic materials from non-magnetic waste.

The non-magnetic material is not attracted to the pulley and drops through the vane assembly to its own receptacle.

About 90 per cent of magnetic material is withdrawn from the material to be separated as it reaches the first vane on the feeder. The remaining 10 per cent drops through the feeder with the non-magnetic material but once again passes the lower face of the pulley at which point the remaining magnetic particles re-enter the magnetic field and virtually complete separation is effected.

RAYOTUBE ADVANCES RADIATION PYROMETRY

▲ Built to work with all L & N "Micromax" and "Speedomax" Rayotube instruments, a new Rayotube represents an important advance in radiation pyrometry. Present users of Rayotubes, as well as future ones, will find this completely new, advanced design detector unusually easy to apply, especially to such equipment as slab furnaces, soaking pits, openhearths, wherever operating conditions are severe.

Quick-sighting optical system lets user select desired target easily, and then check the sharply-defined area which the Rayotube sees. Increased sharpness is also of benefit when radiation comes from end of a closed tube.

Hermetically sealed construction at lens, window, and leadwires keeps out dust and gases. New design guards inherent accuracy and stabil-

HAYS CAN SHOW YOU HOW...

TO IMPROVE MANY PHASES OF STEEL PROCESSING... AND TO CUT YOUR FUEL AND LABOR COSTS.

The bulletin illustrated is not just a piece of sales literature but a complete 24 page treatise on the instrumentation and automatic control of steel making and heat treating furnaces. You'll want a copy for your reference files, want to profit from its practical, authoritative information.

And remember as you read it, Hays engineers are thoroughly qualified and ready to work hand-in-hand with you in solving your own specific instrumentation and control problems . . . without obligation.

Write for your copy today . . . Ask for Bulletin No. 48-750 (covering heat-treating furnaces). Companion edition covering open-hearth furnaces will also be included.

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INSTRUMENTS AND CONTROLS FOR EVERY NEED

Steel that's better, with more uniform grain structure . . . maximum production because of continuous equipment performance . . . fewer rejects . . . lower fuel, maintenance and labor costs—these are advantages you can count on when you use Hays instruments and controls for:

Annealing
Brazing
Colorizing
Carburizing
Cyaniding
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Glazing
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Heat treating
Melting
Nitriting
Normalizing
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For indicating and controlling:
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Flow
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Gas analysis

Inquiries invited on any of these specific applications.

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A NEW ENGINEERING MATERIAL:

Ductile castings

SOMETHING NEW IN THE CASTING INDUSTRY

What is DUCTILE IRON? It is an invention relating to a unique alloy that contains the best features of gray cast iron, malleable iron and steel, with much better physical properties.

DUCTILE IRON IS NEW. Patent was applied for in 1947, and granted October 25, 1949. It is so new that engineers may spend years checking its undeveloped possibilities, qualities, properties and applications. In the "as cast" condition it has a combination of properties of an order entirely different from and higher than that obtained in gray cast iron and steel.

Consumers of ferrous alloy castings, and men who specify the engineering materials will be interested in DUCTILE IRON because: it has a tensile strength of 75M to 90M PSI—elongation 2% to 10%—yield point 55M to 65M lbs.—Brinell hardness 175 to 300—modulus of elasticity 25,000,000 lbs.

Illustration suggests the extreme ductility of DUCTILE IRON. This bar, ½" x ¼" as cast, was twisted cold—and it emits a definite, steel-like ring when struck.

DUCTILE IRON has excellent founding properties, can be readily cast into molds of intricate design, and has better castability than steel. It has unique elastic properties not possessed by gray iron and can be cast in heavier sections than malleable.

DUCTILE IRON may be applied to the manufacture of a wide variety of ferrous products and articles usually made of such ferrous alloys as gray cast iron, pearlitic malleable iron, ferritic or standard malleable iron, and cast steel.

We are licensed to furnish the steel industry castings with the above properties. Send us your drawings and inquiries, and we will show how you can profit by using the revolutionary DUCTILE IRON in YOUR products. Licensed under patent from the International Nickel Company.

TYPICAL APPLICATIONS:
DIES • ROLLING MILL HOUSINGS • APRON PLATES • GUIDES • TABLE ROLLERS • TABLE GIRDERS • GEAR BOXES • COUPLING BOXES • SPINDLES • RAILROAD EQUIPMENT • PRESSURE CASTINGS FOR VALVES, PUMPS • FURNACE PARTS • MELTING AND HEAT TREATING POTS • COMPOSITE PRODUCTS • MACHINE TOOL CASTINGS • CYLINDERS • PLUNGERS • SLAG LADLES

YOUNGSTOWN FOUNDRY & MACHINE CO.

YOUNGSTOWN 1, OHIO

ity, even with high or rapidly changing housing temperatures.

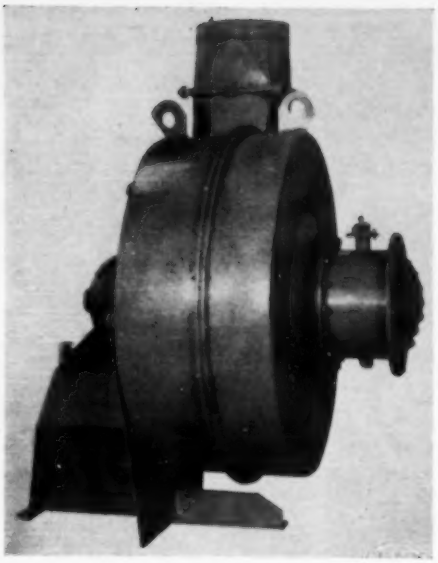
Ease of replacement. Purposely designed for easy, low cost replacement, the new Rayotube fits all existing Rayotube mountings. This unit requires no protection against high ambient temperature unless its housing temperature exceeds the very high figure of 350 F. Below that point, any previously installed water or air-cooling can simply be turned off or disconnected.

USE THE ENGINEERING MART

SEVEN BLOWER SIZES ADDED BY NORTH AMERICAN

▲ North American Manufacturing Co. has recently added to its production line seven new blower sizes to further round out the line of blowers known as the "300" series. These new additions are of the large volume, low pressure type and come in either single or two-stage units. They may be obtained in the directly connected style shown or with V-belts transmitting the power from the motor to the blower impellers through a jackshaft.

Four ounce blowers give 4000 and 4700 cfm with 7½ and 10 hp 1750 rpm motors respectively. Eight ounce blowers give 2480, 4250 and 4800 cfm with 10, 15 and 20 hp 1750 rpm motors. Two blowers with 50 and 60 hp 3600 rpm motors give 6000 and 7560 cfm, respectively.



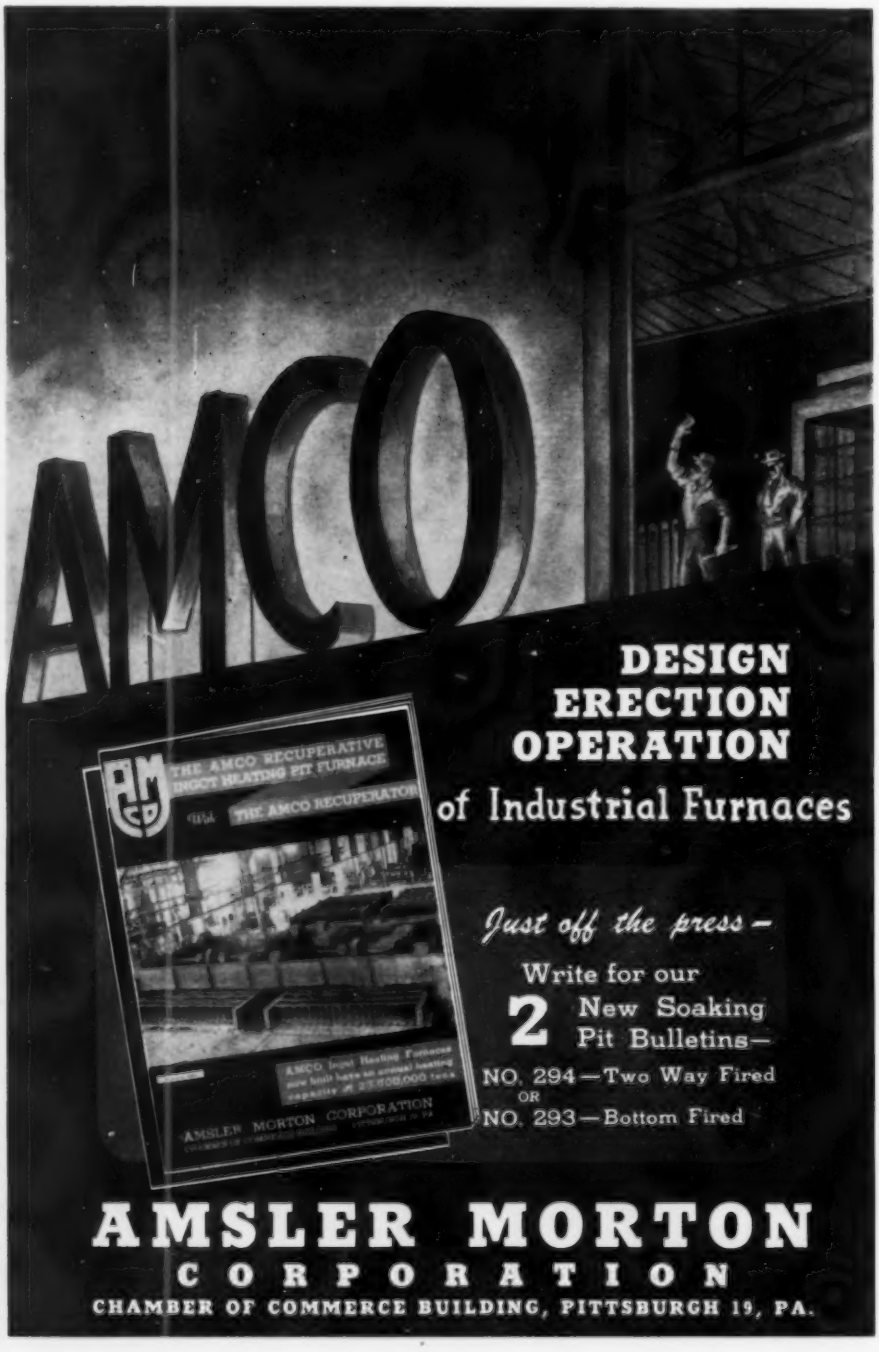
The new additions are of large volume, low pressure type and are made either single or two-stage units.

Like the rest of the "300" line these blowers are vibration free and long on service. Cases and bases are of fabricated steel plate and impellers are of fabricated aluminum, well balanced. The discharge may be ordered in any one of several positions.

LIGHTING UNIT PACKAGES FOR OUTDOOR USE

▲ Thompson Electric Co. has announced the availability of four new all-aluminum unit packages which have been developed especially for all types of outdoor lighting installations. These new packages contain a complete Thompson disconnecting and lowering hanger, a lighting fixture adapter (for either pendant or yoke-type fixtures), a slip-fit elbow, bracket end, U-bolts, filler blocks, a fixed position corner pulley, a specified length of galvanized chain, and (optional) an open-type lock box with a spring-loaded terminal link or a fully enclosed, pulley-equipped lock box for use with conduit enclosed vertical chain runs. The enclosed lock box is weather and tamper-proof.

These unit packages have a wide range of outdoor applications for industrial plants, switch yards, loading docks and shipping platforms. They facilitate continuous, safe, easy lighting fixture maintenance.



NOW *is the time* PREPARE FOR LOWER MAINTENANCE...

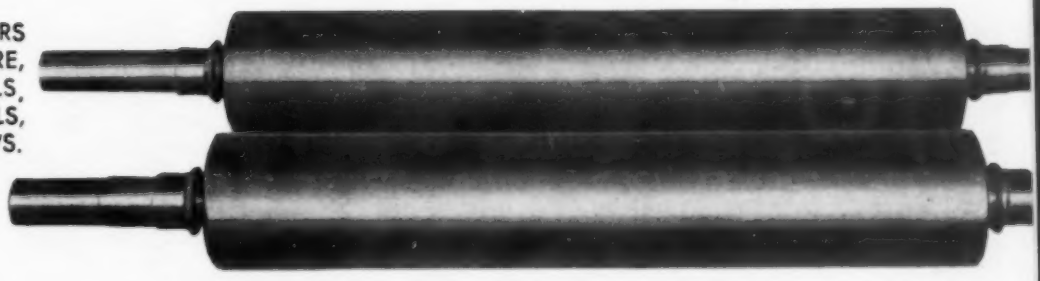
IN ADDITION TO OUR HIGHLY STANDARDIZED LINES OF TUBULAR CARBURIZED ROLLERS WE MAKE EVERY SORT OF SPECIAL ROLLS FROM ALLOY FORGINGS OR ELECTRO-CAST STEEL.

WE HAVE MADE HUNDREDS OF SMA HIGH SPEED ROLLS, WELL BALANCED FO LONG LIFE.

LONG LIFE, SOLID FORGED PINCH ROLLS AND FLATTENERS.

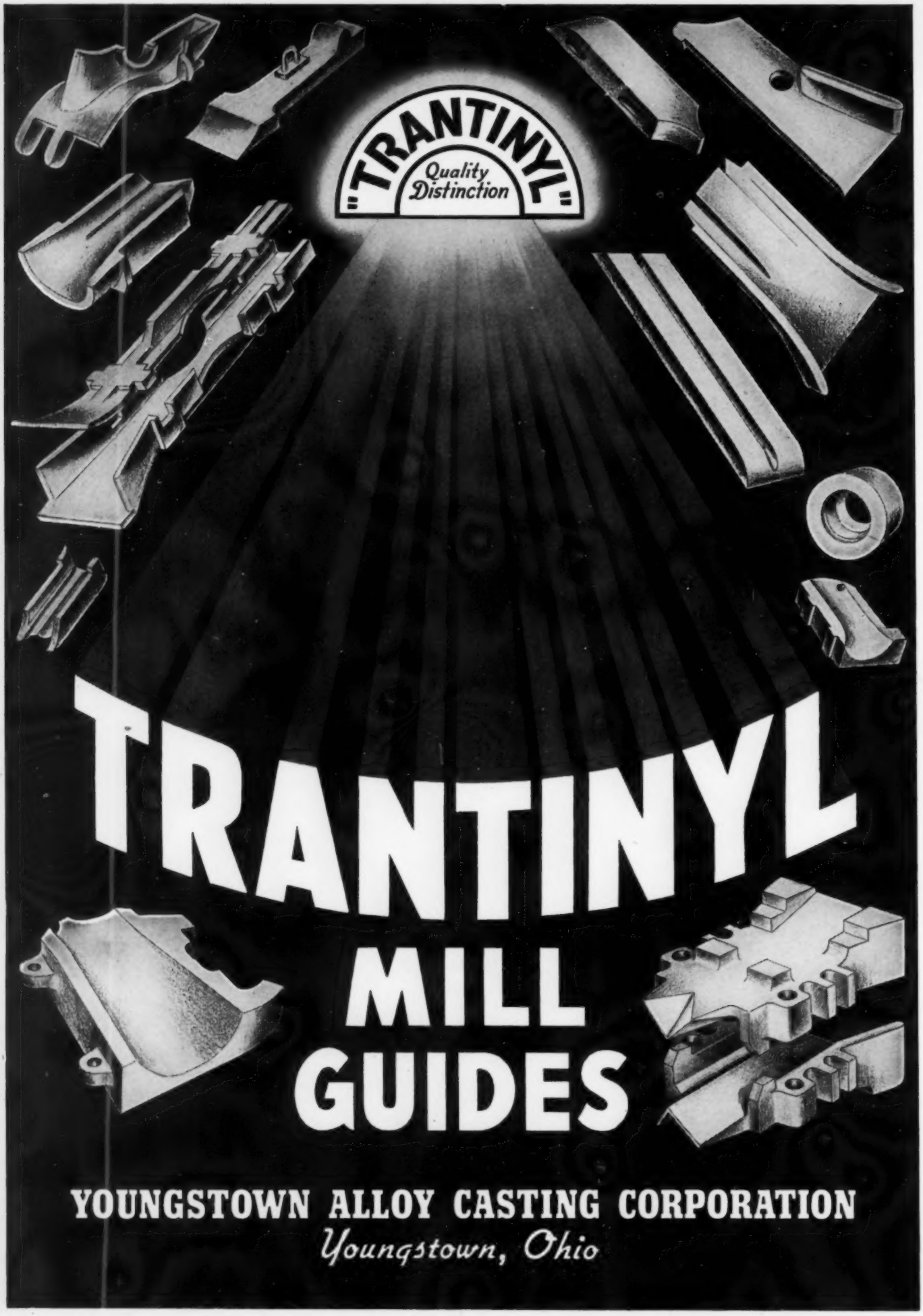
UNCOILER ROLLS SUCH AS THESE MADE FROM ELECTROCAST MILD STEEL ARE UTTERLY RELIABLE AND WILL GIVE LONG LIFE AT REMARKABLY LOW MAINTENANCE.

HEAVY FORGED SOLID ROLLERS FIT INTO EVERY MILL PICTURE, ALSO: HARDENED BRAKE WHEELS, PINCH AND FLATTENER ROLLS, SCREW-DOWN NUTS AND SCREWS. **LET US HELP YOU!**



use and specify **BADALL** *Long Life* **EQUIPMENT**

Badall Engineering and Manufacturing Company Hammond, Indiana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(1) Cutting Production Costs

"Cutting Production Costs with Electronic Controls" is the title of a new book which contains 45 case studies describing actual examples of cost-saving production techniques. This book includes no catalog information. Its 65 pages are filled with facts showing how photoelectric and electronic controls solve problems and prevent bottlenecks in industry. This book has been prepared for those whose operations will profit by the use of electronic and photoelectric controls. Each of these case studies describes an industrial control problem which has been solved through the use of electronics. The applications have been chosen from thousands of installations because of their general interest, and because each will suggest related uses in other fields. To assist in quickly securing useful information, an index lists the applications both alphabetically and by industries. (PG4910). Photoswitch, Inc.

(2) Scrap Handling Equipment

A new bulletin, illustrating various kinds of P&H equipment for handling scrap, has just been issued. It carries numerous on-the-job pictures of overhead cranes, truck cranes and crawler cranes equipped with magnet, bucket and slings in all types of scrap handling service and shows many cost-saving ideas. (X-121). Harnischfeger Corp.

(3) Pig Casting Machine

The Bailey redesigned stationary-wheel pig casting machine for ferrous and non-ferrous smelters and foundries is the subject of a new 4-page bulletin just published. The bulletin includes several views of the redesigned model and pictures the different machine parts, both individually and assembled. The various sized machines available and their capacities are also given. This redesigned machine retains the principal features of the original Bailey stationary-wheel type machine which eliminates 80 per cent of the moving parts of conventional pig casting machines and requires almost negligible maintenance. A chain of 15-in. cast links, connected by high manganese steel bushings and pins, replaces the customary track of most pig casting machines, and the slight wear that occurs as the chain moves over the end sprocket wheels is confined to these bushings and pins. William M. Bailey Co.

(4) Telemetering Systems

A 20-page bulletin, which describes the newest telemetering equipment for electric power distribution and industrial applications, has just been released. The bulletin gives detailed information on the frequency type, torque-balance-type, and photoelectric-type telemeters. Included also are simple wiring diagrams of typical telemetering installations for various services, and descriptions, dimensions, and specifications of telemeters and auxiliary equipment, such as torque-balance converters and torque-balance load injectors. (GEA 5233). General Electric Co.

(5) Mechanical Shaft Seal

For installation on equipment, moving or transferring liquids, which requires a positive shaft seal, as well as for replacement of conventional stuffing boxes where packing has proved unsatisfactory, a new mechanical shaft seal has been developed to provide as perfect a mechanical means for prevention of leaks around a rotating shaft as is possible. This new seal is described in a new folder which is available. (B-571). Peerless Pump division of Food Machinery and Chemical Corp.

(6) Code Symbol Stamps

Standard code symbol stamps for identifying inspectors, operations, workmen, dates, and specially designed stamps for indicating acceptance, rejection, deviation and other inspection markings are the subject of a new folder just issued. The folder includes reproductions and listings of standard date coding and piece work symbols, code symbol and number combination stamps — available from stock, and the specially designed code symbol stamps made to order. Standard stamp sizes are also given. These stamps are made of special alloy safety steel in regular or wedge grip styles. M. E. Cunningham.

(7) General Purpose Hoists

Two new catalogs covering a line of general purpose hoists are announced. Both catalogs are illustrated with operating pictures as well as illustrations of mechanical parts and assemblies. Catalog No. 100-H-40 covers general purpose hoists from 5 to 40 hp. Catalog No. 100-H-55 covers hoists from 50 to 100 hp. American Hoist & Derrick Co.

(8) Synclinal Filter

A folder is available describing a synclinal filter which has achieved a fine reputation in sump type installations, especially in hydraulic equipment. The filter is now available for a wide variety of liquid line installations. In response to engineers, designers and maintenance men who wanted to use this synclinal filter more widely, the firm has developed a housing that allows their unit to be inserted into any pipe carrying non-corrosive liquids. (202). Marvel Engineering Co.

(9) Battery Technology Handbook

A revised second edition of a 40-page pocket-size handbook of technical instructions and engineering data on the care of motive-power storage batteries is available. The revised handbook contains a new four-page section on the theory of the lead-acid battery. Included in this section are line drawings which clearly indicate what goes on when a battery charges and discharges. Text gives basic information on specific gravity changes, charging and discharging cycles, positive and negative plate composition, and other

battery operation principles which constitute the theoretical background upon which good care and maintenance procedures are based. Following the theory section are four "practical" sections — Care and Operation; Maintenance and Repairs; Parts; and Technical Data. Gould Storage Battery Corp.

(10) Micarta Data Book

Copies of the recently-revised 36-page micarta data book are available. Published as a working tool for the designer and user of industrial materials, the data book presents clearly and completely the technical facts about micarta. The grades and forms in which micarta is supplied are tabulated, together with the chemical, mechanical and electrical properties of each. Standard shapes and sizes available are listed, and a description of finishes is included. (B-3184-D). Westinghouse Electric Corp.

(11) Shaft Data Bulletin

A new shaft data bulletin is available. This bulletin contains a collection of data that should be useful to you. It contains formulae, curves and tables that will materially assist designers in determining proportions, stresses, combined torsional and bending loads, etc. in round, square, hollow, keyway and stepped shafts. This data was originally compiled for use by our own engineers. However, since shafting in some form is universally used in the construction of machinery, it should prove useful to designers and engineers everywhere. (G-7). De Laval Steam Turbine Co.

(12) Dust Control

How you can initiate the 1001 savings stemming from dust control by a simple "wet water" arrangement involving no capital investment, is the story told in a new folder titled "Controlling Dust in Industrial Plants," just released. Aquadyne Corp.

(13) Instrument and Control Panels

An 8-page booklet is available explaining how Hays panels are made and where they are used. All the operations of fabrication are discussed and illustrated — layout, cutting, drilling, welding, fitting, painting, wiring, etc. Particular features like electric clocks, pressure gages, transformers, name plates, push-button stations, signal lights are explained. (773). Hays Corp.

(14) Electrostatic Precipitation

A new 16-page bulletin on electrostatic precipitation has been announced. Illustrated with photographs and diagrams, the publication explains how electrostatic precipitation works, gives case histories of seven typical installations where the system is being used, and describes the various methods of electrostatic precipitation and the electric equipment applicable to each method. Recognized as the most efficient method known today for the control of small particles of matter, either liquid or solid, electrostatic precipitation is used for air cleaning, gas cleaning and recovery, painting, deposition, orientation, and separation. It can collect cigarette-smoke particles as small as 1/100,000 of an in. in diameter, or deposit fibers as long as 1/4 in. on an adhesive-coated cloth to make pile rugs. It is finding application in acid plants, blast furnaces, gas plants, power plants, smelters, and elsewhere. (GEA 5212). General Electric Co.

(15) Diesel Engines

Superior diesel engines for stationary installations are described and illustrated in a new 20-page bulletin. The bulletin features 60 years of Superior engine research and production development, and numerous installations of these engines within the past three years in power plants. Included are more than 100 engine specifications showing a range in power from the naturally aspirated, 6-cylinder, 175-hp engine with 8½ x 10½-in. bore and stroke, to a supercharged, 8-cylinder, 1500-hp engine with 14½ x 20-in. bore and stroke. (4812). Superior Engine division of National Supply Co.

(16) Large D-c Generators

The answer to efficient, reliable d-c generator operation under all conditions of service is contained in a new 20-page illustrated bulletin just released. Entitled "Allis-Chalmers Direct Current Generators," the bulletin describes the construction of units larger than 150 kw or 0.3 kw per rpm. These include two and three-wire generators and exciters, both engine and coupled type. It also discusses the operation of shunt wound and compound wound generators in parallel. The bulletin concludes with a description of the frog-leg armature winding developed by Allis-Chalmers and identified as a "combination of wave and lap winding, perfectly equalized, providing good commutation without cross-connectors." It is generally used on motor-generator set generators of 100 kw and larger, synchronous converters of 200 kw and larger, and all large low speed generators. (05B7229). Allis-Chalmers Manufacturing Co.

(17) Air Compressors

A new 16-page, fact-packed bulletin on "WL-80 Unitair" compressors is available. This bulletin includes an easy-to-use selector chart plus detailed section drawings and parts photographs illustrating economy and operating features. The compressor is available in 11 sizes, 15 to 125 hp with piston displacements from 81 to 640 cfm at 125 maximum pressure. These two-stage, air cooled compressors are furnished as complete motor driven units with three standard electric drives including built-in motor, direct-connected and V-belt drive. The compressors may also be equipped with gas or diesel engine. (A-56). Joy Manufacturing Co.

(18) Selector Chart

A new selector and comparison chart of hardfacing rods and electrodes has been released. This chart lists each of Amsco's welding rods and electrodes and indicates the type of service for which each is designed. Metallurgical and physical descriptions of each rod are so arranged as to simplify selection by the user of the right rod for the right job. For comparison purposes, competitive rods which are the closest equivalents for the service noted, but not necessarily of the same composition or performance as Amsco rods, are also listed. (CC-3). American Manganese Steel division of American Brake Shoe Co.

(19) Recuperative Heating Furnaces

Two booklets are available to you on AMCO recuperative ingot heating pit furnaces. The first booklet discusses bottom fired furnaces and gives a complete technical plan and section with the general description of the furnace. Includ-

ed are operating principles and characteristics, furnace controls, furnace performance, and a chart showing typical heating characteristics. The second booklet discusses a two-way fired furnace and is also complete with the same type of material as the first bulletin. Both of these bulletins should be in the files of every person interested in ingot heating. (293 and 294). Amsler Morton Corp.

(20) Examples of Rectifiers

A very complete file is available on various examples of rectifier engineering. The file contains several booklets and technical articles with other technical data on rectifier equipment. It has been designed to show the range of requirements with which this company has dealt. This company started with selenium rectifier equipment of the low voltage, high current type, designed especially for such metal finishing uses as electroplating, anodizing, cleaning, etc. Then they went on to build other units for higher voltage applications. They are now designing and building rectifier units using tubes designed to deliver voltages as high as 10,000 volts. W. Green Electric Co.

(21) "A Blueprint . . . .

. . . . for the Iron and Steel Industries" is the title of a very complete booklet that is available to you. This booklet shows the various accomplishments of the H. A. Brassert Co. throughout the world. It tells about the wide range of engineering functions of the company from the preparation of initial surveys to the installation and operation of complete facilities for the manufacture of finished products in the iron and steel and allied industries. Every chief engineer, vice president of operations, and general superintendent in the steel industry should have this book in his files. H. A. Brassert and Co., Inc.

(22) Pump Valve Service

A revised bulletin on pump valve service is available. The bulletin discusses pump valve units designed to operate in water, oils, acids, alkalies, air and gases at all temperature-pressure combinations. They are constructed for increased pumping efficiency and long life, whether handling vacuums of one micron or discharge pressures of thousands of pounds psi. Tabular information is included in this catalog showing dimensions of these valves with a description of the best way to order the valve. (911F 1-50). Durabla Manufacturing Co.

(23) Bending Presses

A catalog is available describing powerful precision-built presses for plate of thicknesses to one in. and lengths to 20 ft. This catalog gives construction details, dimensions and specifications together with data required for quotations. (2010-E). Cleveland Crane and Engineering Co.

(24) Worm Gear Speed Reducers

A catalog is available describing worm gear vertical speed reducers. The catalog tells how these units are particularly suited to such equipment as agitators and mixers, and for use in connection with supplementary low-speed spur-gear drives, without outboard bearings. The catalog gives outstanding features, complete dimensional data, cross-section drawings and thrust and overhung load capacity charts. (125). Cleveland Worm and Gear Co.

(25) Blowers and Exhausters

A catalog is available describing electric blowers and exhausters for all services requiring constant air pressure up to 5500 cfm. These units are available in twelve sizes. Pressures up to one and three-quarter pounds enable you to select the proper unit for your requirements. Nine tables are included giving capacities and static pressures of the blowers. Included also are dimensional drawings with various size information. Buffalo Forge Co.

(26) Steel Mill Furnaces

Two bulletins are available on steel mill furnaces. The first describes a furnace engineering service covering your heat treating problem from original planning to successful operation. The second describes galvanizing furnaces and equipment which are engineered for your particular requirements. It tells how in one large pipe galvanizing plant, this furnace setting increased kettle life from 20,000 to 70,000 tons, with refractory baffle life now in excess of 3½ years. Furnace Engineers, Inc.

(27) Fire Clays and Brick

A folder is available describing ground and screened fire clay for open hearth furnace spouts and runners, blast furnace tap holes and troughs, and mortar for fire brick joints. The folder also describes fire brick for lining iron and steel ladles and furnace construction. Also included in the folder is a description of "Therm-O-Flake" high temperature insulation. Illinois Clay Products Co.

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51	BEDFORD FOUNDRY AND MACHINE CO.		Catalog available on Bedford cranes with capacities from 5 to 150 tons.
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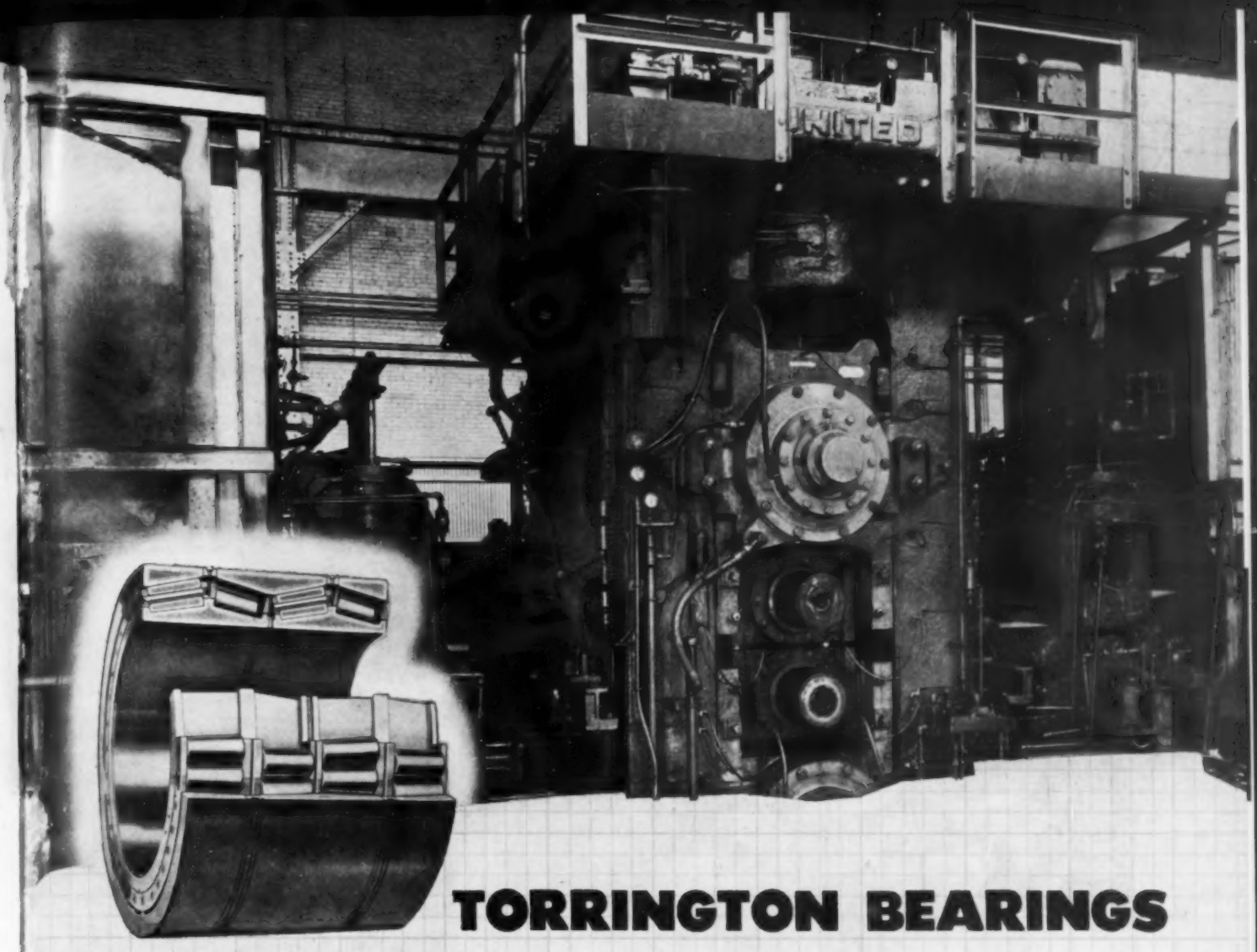

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help roll Crucible's quality stainless steel

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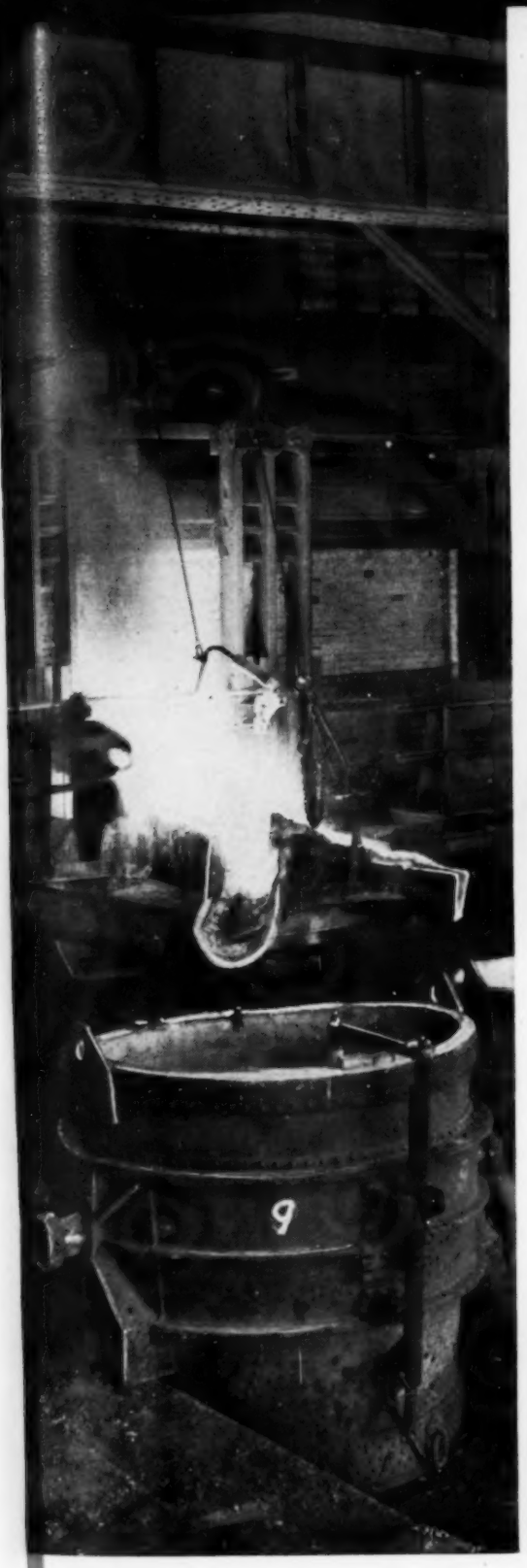

At the blast furnaces and open hearths, oxygen plays an important part. Furnace-tapping with the oxygen lance—oldest use of oxygen-cutting in steel plants—still saves time and reduces hazards.

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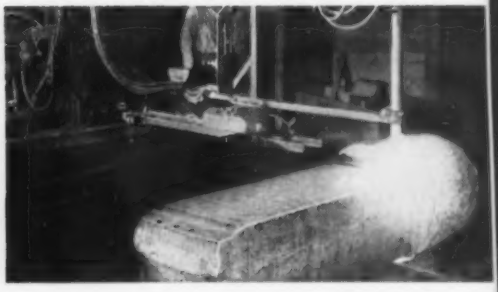
Ingots requiring 200 hours for mechanical "parting" have been split with the OXWELD C-45 heavy-duty blowpipe and then machined in 14 hours total time.



Cutting the hot top off this 26-inch forged slab with the C-45 blowpipe took less than 10 minutes and left the slab end square and undeformed.

The deseaming blowpipe, equipped with the OXWELD starting-rod feed, has reduced conditioning costs more than 50 per cent.

Draining furnace salamanders by oxygen-lance tapping has reduced furnace down-time more than three weeks in some steel plants.

LINDE service engineers who co-operate closely with the steel industry—have combined experience, knowledge, and practical "know-how" to help make better steel, faster, and at lower cost.

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The welded grid assembly is shown here as a unit resting on narrow iron straps above its end frame, support rods, and spacers.

Steps Up RESISTOR Performance these 3 ways

TAB-WELD Resistors as part of Factory-assembled Control for recent Ore-Bridge Installation.

The *welded* grid-assembly of the EC&M TAB-WELD Plate Resistor reduces resistor maintenance costs and improves operation.

HERE'S HOW:

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For low-cost, trouble-free operation, make up resistor layouts with EC&M Bulletin 942 TAB-WELD Plate Resistor Sections, made from corrosion-resistant steel.

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FULL PORT *Self-Seald* LUBRICATED PLUG VALVES

. . . the Lowest Priced, Full-Port-Area Plug Valves In Their Rated Working Class

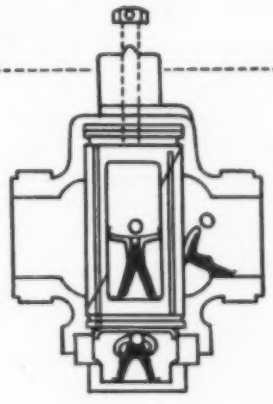
If you're using a venturi (restricted-port-area) valve with an opening of say, 60% standard pipe area, you are operating at reduced line pressure. To be sure of nearly full line pressure, you must use a larger size venturi, which of course means a higher priced valve . . . perhaps as much as 30% higher!

For example: **A 2½" Homestead-Reiser has a 100% full-port-area, or 4.78 sq. in. The 2½" size in 60% venturi pattern has only 2.87 sq. in. port area. To approximate the full-port-area of a 2½" Homestead-Reiser valve, a 3" venturi must be used. And even then you'll have less than Homestead-Reiser's full-port-area.**

In the light of this evidence doesn't it stand to reason that Homestead-Reisers with their 100% full-port-area are sound economy?

Truly, from the standpoint of both first cost and length of service, they are the lowest priced, full-port-area lubricated plug valves in their rated working class!

← For complete information, write for Catalog 39, Section 5. We'll mail it to you promptly.



"SELF-SEALD" MEANS

. . . that in addition to a full-port lubricant seal the wedge-action of the plug under line pressure, forces the finished surfaces of the plug outward and constantly presses them against the seating surfaces of the body, thus keeping them always in intimate contact. The plug automatically adjusts itself for wear, assuring extra long life, maximum leakless service and lubricant economy.

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"Serving Since 1892"

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Manufacturers and patentees interested can contact him through Box 302, ASSOCIATION OF IRON AND STEEL ENGINEERS, 1010 Empire Building, Pittsburgh 22, Pa.

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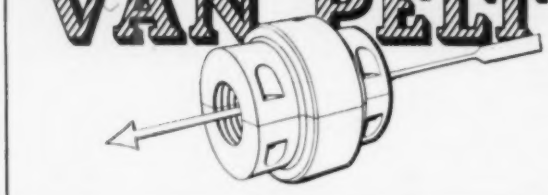
VAN PELT ★ MOTOR ★ CHANGEOVERS



Many of the crane and auxiliary motors in the bessemer plant at the Aliquippa works of Jones & Laughlin Steel Corporation have been changed over to roller bearings and the program calls for complete conversion. Nearly 3000 VAN PELT MOTOR CHANGEOVERS have been installed in the J&L Aliquippa works alone since 1924.

★ FROM SLEEVE BEARINGS TO RAILWAY ROLLER BEARINGS

In the dusty atmosphere which prevails in steel mills and similar industries, VAN PELT MOTOR CHANGEOVERS, equipped with the latest types of Railway Roller Bearings, increase the bearing life of those older motors (mill, crane and general purpose) previously running on ring-oiling sleeve bearings far more than 10 times. This has of course materially reduced downtime and therefore increased tonnage.

VAN PELT MOTOR CHANGEOVERS can effect these same economies in every department of your plant as well.

VAN PELT ELECTRIC CO.

105 FAHNESTOCK ROAD • PITTSBURGH 15, PA.

Farval provides perfect lubrication for world's largest tin dredges

THE bearings on the digging ladders of these dredges are subject to heavy shock loads and continuous vibration. For days at a stretch they are immersed in corrosive salt water, in the excavation of tin bearing sand. Yet the bearings function perfectly because each one is protected by a tough, unbroken film of lubricant supplied by Farval Centralized Lubricating Systems.

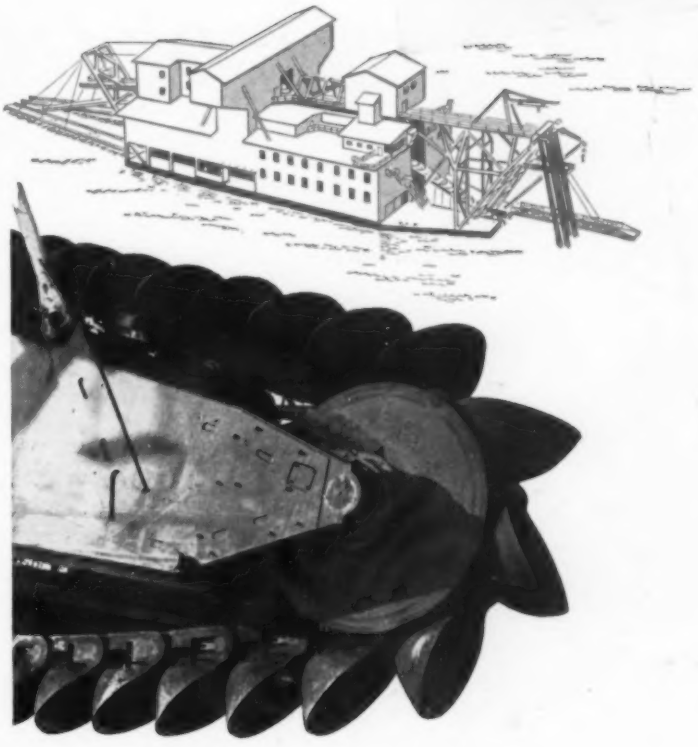
The tin dredge pictured here is one of nine such Farval-protected giants operating in the Dutch East Indies. Its digging ladder is 216 feet long, operates 100 feet under water. The super structure stands as high as a 9-story building. Other similar recently built mining dredges, lubricated by Farval, dig for gold in Africa, Russia and the American west—nearly a score in all.

Where expensive, heavy-duty bearings must function continuously under heavy loads, or in any difficult conditions—where success depends on adequate protection of bearings—there you'll find Farval on the job. On thousands of machines all over the world, Farval Centralized Lubrication has long since proved its ability to save labor, lubricant and time, eliminate delays, reduce maintenance expense and repairs, and increase production.

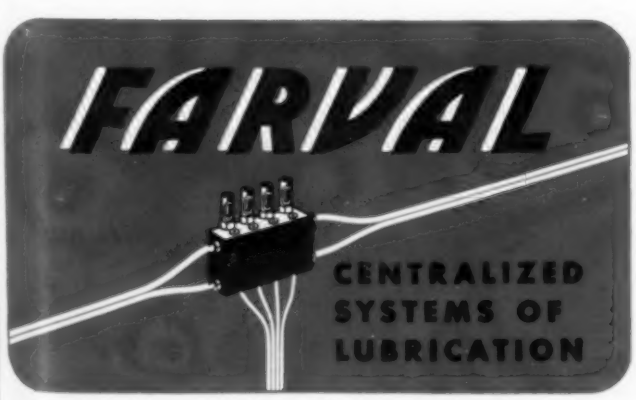
Farval is the original (patented) Dualine system of centralized lubrication that has proven itself through years of service. The Farval valve has only two moving parts—is simple, sure and foolproof, without springs, ball-checks or pinhole ports to cause trouble. Through its full hydraulic operation, Farval unfailingly delivers grease or oil to each bearing—as much as you want, exactly measured—as often as desired. Indicators at every bearing show that each valve has functioned.

Write for Bulletin 25 for full details. The Farval Corporation, 3278 East 80th St., Cleveland 4, O.

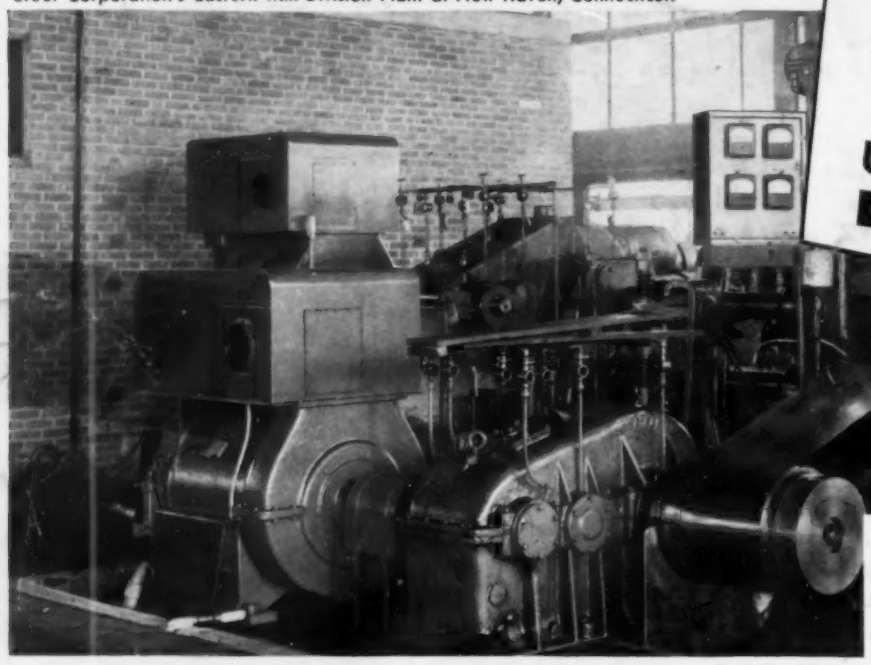
Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing. In Canada: Peacock Brothers Limited.



FARVAL—*Studies in Centralized Lubrication* No. 114



The two G-E double-blower unit-cooled d-c motors shown at left, each rated 100 hp, operate the main drive and reel on a single-stand 2-high skin-pass mill, installed at Detroit Steel Corporation's Eastern Mill Division Plant at New Haven, Connecticut.



unit-cooled D-C MOTORS

self-protected...to cut installation costs!

In dusty, dirty or oil-laden atmospheres—where open motors can't take it without special protection—you can cut installation time and costs to a minimum with General Electric totally-enclosed unit-cooled d-c motors. Motor and unit cooler, completely factory-assembled as a unit, come to you ready to install. They need no specially-built motor room, no piping, ductwork, coolant, filters or pressurized air supply. You simplify plant layout, save extra equipment cost!

These better-protected, better-cooled G-E motors—available in ratings from 15 to 200 hp—also

. . . **minimize inspection shutdowns!** Windings, brushes and brush rigging are kept clean at all times because harmful air-borne materials can't get into the motor's internal ventilating air.

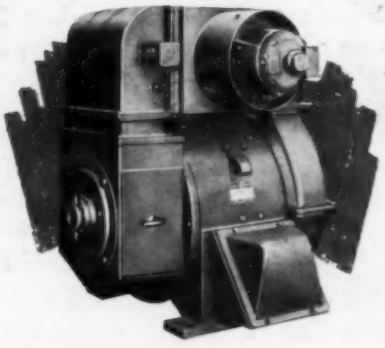
. . . **reduce power cost!** Because motor heat is rapidly dissipated, power consumption is less, especially in wide-range adjustable-speed motors.

. . . **simplify maintenance!** Large openings in the commutator end shield make it easy to get at commutator, brushes, and brush rigging.

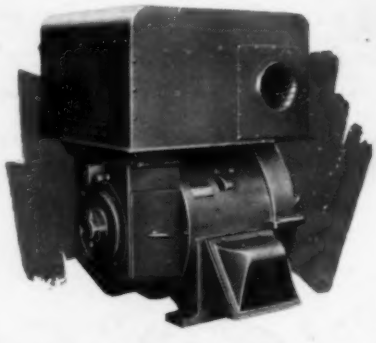
. . . **save mounting time!** Interchanging of motors to meet changing mill conditions takes less time because G-E totally-enclosed motors have the same mounting dimensions as G-E open motors of the same ratings.

Get the whole story! Ask your G-E representative how these sturdy, protected motors can help trim operating costs in *your* mill, or send for Bulletin GEA-4469. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

A choice of types to meet your needs



In single-blower type— for constant and adjustable speed operation at normal speed—unit cooler circulates internal air with a shaft-driven fan. External air is forced through alternate air passages by a separate motor-driven blower.



New double-blower type— can be operated continuously without harmful overheating, even at very low speeds. A single Tri-Clad® auxiliary induction motor drives both blowers, one for internal motor air, the other for external cooling air.

GENERAL ELECTRIC

/70-18